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Training Manual

No. 2

Army Air Service

1917

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CHAPTER I.

GENERAL SYSTEM OF MAINTENANCE.

The system of maintenance as regards the supply of material and repairs will be divided as follows:

1. Port of Debarkation.
2. General Aircraft Depot.
3. Advance Depots.
4. Wing Parks.
5. General Repair Depot.

1. *Port of Debarkation.*—Airplanes will be assembled, tested and flown to General Aircraft Depot and Training Stations, if not too distant from Port. General spare parts will be shipped by rail from Port of Debarkation or factories to General Aircraft Depot and Training Stations. Capacity of Port will be 2,000 airplanes per month.

2. *General Aircraft Depot* will supply all Advance Depots and Training Stations with spare parts, material, oil and gasoline, making all shipments by rail.

The function of General Aircraft Depot is to hold and maintain in efficient condition the reserve airplanes, engines, aeronautical material, mechanical transport, and technical stores and issue them as required.

3. *Advance Depots.*—Each Advance Depot supplies complete planes, spare parts and equipment and Reserve Pilots to 50 Aero Squadrons and 3 Balloon Squadrons.

Complete planes are flown by Reserve Pilots direct to squadrons.

Capacity of Advance Depot is 250 complete planes, 1,000 sets of spare parts and additional tools, equipment, etc.

4. *Wing Parks.*—Functions of the Wing Parks is to supply spare parts, gas, oil, etc., direct to the squadrons, and make all minor repairs to airplanes, engines, motor vehicles and instruments. Badly damaged airplanes, engines, motor vehicles or instruments will be forwarded by rail to the General Repair Depot.

5. *General Repair Depot.*—There are three echelons in the field for the repair of airplanes and motors.

First.—The airplane sections with the squadrons who are responsible for the care and maintenance of the airplanes on squadron charge. These sections are able to carry out petty repairs and replacements.

Second.—The repair sections at Wing Parks are capable of making more extensive repairs to airplanes and engines.

Third.—The General Repair Depot is equipped with means for making extensive repairs and overhauls to airplanes and engines, and is responsible for the supply of reserve airplanes, reserve engines and spare parts.

Every airplane will carry as part of its equipment a few tools for effecting minor repairs such as replacing spark plugs or repairing broken gas leads. When on the move, covers for engine, propeller and fuselage with means for pegging down the airplane in the open will be taken.

Should an airplane be compelled to make a forced landing and require repairs, the pilot will send a message by the most expeditious means to his Squadron Commander, giving a full statement of all the damage incurred. Should the damage be of a minor nature the Squadron Commander will send out a detachment in a light tender to effect repairs.

Should the damage be such that it cannot be repaired by the detachment with the material at their disposal, details will be sent back to the squadron by the quickest means. Two courses are then open to the Squadron Commander. He may send out a motor truck with a trailer to fetch back the damaged machine, or send out spare parts to the spot. In making his decision he must consider what course will render the airplane fit for action in the shortest time. The distance, the time required to effect the repair, and the probability of more machines being damaged later on, must all be taken into consideration. In certain cases it may be possible to send in the broken or damaged parts to the squadron for repair.

In cases of still more serious damage, the airplane must be sent back to the Aircraft Depot, or else abandoned altogether. In the latter case the engine, instruments, and all parts which will be useful for repair, especially turnbuckles and metal fittings, will be taken off the machine, and those articles which are not required by the squadron will be sent back to the Aircraft Depot. In either case one of the spare airplanes in the Advance Depot will be brought to the front under arrangements to be made by the Squadron Commander, the normal method being by air.

When an army is advancing it will frequently be advisable to abandon a damaged machine temporarily, the repairs being effected after the squadron has moved forward.

LANDING GROUNDS.

1. Whenever possible, landing grounds for aircraft will be selected by an officer of the Flying Corps. In marking them it should be borne in mind that the signals employed may indicate the position of headquarters to the enemy's aircraft.

2. *Classes of Landing Grounds.*—Landing grounds may be either permanent or temporary. Permanent landing grounds are used by Detachments, Squadrons, or Wings. Temporary landing grounds are used as report centers, or day landing grounds, when no good permanent ground is available at the point required.

3. *The Selection of Landing Grounds.*—The following will be observed in selecting landing grounds:

(*a*) When there is a choice between two landing grounds, the one in more open country should be selected.

(*b*) Roads sufficiently good for heavy motor trucks should lead to the grounds. A side road leading to it, unused by ordinary traffic, is also of great use if transport can be parked on it.

(*c*) A permanent landing ground should be at least 300 yards $\times$ 300 yards in size. A temporary ground, for a few airplanes only, may be as small as 200 yards $\times$ 200 yards if the approaches are open. If trees or telegraph lines border the ground, a minimum of 300 yards, to clear the obstacle, is necessary. This distance must be increased if the trees exceed 50 feet in height.

(*d*) A good shape for a landing ground is an "L" when the minimum length of the arms should not be less than 300 yards and the breadth

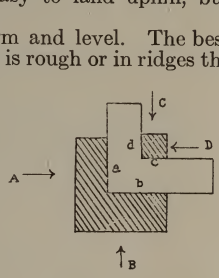
200 yards. An "L" shaped ground is particularly useful if protection against weather is naturally provided by the position of trees or houses as in the diagram.

When the wind is blowing from *A*, the airplanes are parked at *a* and so on.

"T" shaped landing grounds are also often to be found. The length of the arms in this case should not be less than 300 yards, or the breadth less than 200 yards.

(*e*) Landing grounds should be as level as possible. Although airplanes can rise from and land on sloping ground, the wind will often make such landing difficult. An airplane rises and lands up wind. It is easy, therefore, to rise when going down hill, but difficult to land under the same conditions. Similarly, it is easy to land uphill, but difficult to rise.

(*f*) The surface of the ground should be firm and level. The best surface is short grass or stubble. If the surface is rough or in ridges the landing gear is apt to break on landing. If the surface is soft the airplane may tip up and break the propeller, or it may be impossible to rise at all. Plough and ridge and furrow are unsuitable.



(*g*) Landing grounds at the bottom of hollows should be avoided if possible, as they frequently become water-logged in wet weather.

(*h*) Landing grounds with telegraph posts and wire on their boundaries should be avoided.

4. *Improvements.*—In the field, landing grounds are few and far between, but much can be done to improve them. This is one of the duties of Field Companies of Engineers. Landing grounds may be improved by—

(*a*) Rolling soft or rough ground. Steam rollers are best for rough and hard surfaces, but a large stone or iron roller weighted with pieces of timber is suitable for soft ground. If it has been necessary to select soft ground, and no rollers are available, a good deal may be done by a body of men, such as a company of infantry, trampling down the ground.

(*b*) Levelling off the ground with a road grader and rolling and trampling dry plough which is not ridge and furrow.

(*c*) Filling up and rolling drains and ditches running across the ground.

(*d*) Cutting down trees and high hedges when the space for landing is less than 300 yards. Trees must be felled so that they fall away from the landing ground.

(*e*) Filling up large pot holes and rolling. If there is insufficient time to do this, a red or yellow flag, or a square of red or yellow cloth, should be placed in the center of the pot hole. Care must be taken that any filled-in ground is made firm and solid.

(*f*) Marking any other dangerous places such as ditches at the edge of the ground.

(*g*) Telegraph posts and wires, and wire fences or iron railings, must be marked by hanging strips of cloth or blankets on them, and the Signal Corps should be asked to take down any air lines which might prove dangerous to airplanes, and to substitute ground lines.

All work on a landing ground should begin from the center and proceed outwards, in order that a space for a machine to land on may be provided as quickly as possible. With well directed work very unlikely looking places can be turned into practicable landing grounds in a day. Working parties must not leave their tools lying about on the ground, and when they see a machine about to descend must at once clear the ground.

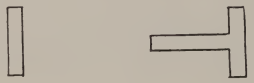
METHODS OF MARKING A LANDING GROUND.

5. *By Day.*—Three strips of white cloth arranged as a "T." The head of the "T" should face directly into the wind thus—

Direction in which a pilot should land.

This gives the direction in which the pilot is to land. (The position of the "T" must be changed with any change of the wind).

A landing ground, used as a report center for an Infantry Division, will be marked by a "T" with a bar 10 yards in rear of it, thus—



A landing ground, used as a report center for an Infantry Corps, will be marked by a "T" with two bars similarly situated, thus—

Direction in which a pilot should land.

The strips of cloth should measure 15 feet by 3 feet.

6. Report centers for dropping messages when airplanes are not to land are marked as under, by means of strips of white cloth measuring 15 feet by 3 feet.

Advanced guard report center	X
Infantry divisional report center	X
Infantry corps report center	X
Cavalry corps report center	OI
Indian Cavalry report center	OII

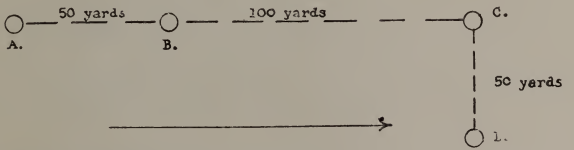
7. A landing ground or report center for Cavalry will be shown by the following ground signal added to the signals given above:—

(*a*) A circular strip of cloth, with an inside diameter of 8 feet, the strip being 2 feet broad, and with a fixed indicating point, A.

(*b*) A triangle of cloth B, with 4 foot sides.

The relative positions of the triangular piece of cloth will be changed at frequent intervals so that it cannot be copied by the enemy. Instructions regarding this will be issued by General Headquarters.

8. By night, landing grounds will be marked with four flares as under—



Direction in which a pilot should land.

The pilot will then understand that he is to land near flare "A" or "B," and that all ground between flare "A" and flares "C" and "D" is good for landing and free from obstacles. If available, white sheets with a shaded light, such as a bicycle lamp shining on each, may be substituted for flares "A" and "B".

Searchlights or acetylene lamps may be used to light up the landing ground. They must, of course, be pointing in the same direction as that in which the pilot will land.

If possible, all other lights within a radius of one mile of the landing place should be extinguished, but parts of the landing ground likely to cause damage should be marked with red lamps. The most suitable form of flare is a bucket with half a gallon of gasoline in it. This will burn for half an hour and is visible from 8 miles off on a clear night even when the moon is half full.

On a bright moonlight night, flares and lamps may be dispensed with and the same signal used as for day. The airplane should be attracted to the spot by means of rockets or Very's lights.

CHAPTER II.

THE EMPLOYMENT OF AIRPLANES IN WAR.

A. Characteristics and Principal Duties of Airplanes.

1. Airplanes have a radius of action and speed which varies considerably with the type of machine. The average distance which an airplane can cover in calm weather is 250 miles, and the average speed is about 70 m. p. h. If properly looked after they may be left in the open for considerable periods without serious deterioration. Different types

are constructed and equipped for particular duties, *i. e.*, for reconnaissance, artillery observation or offensive action, but although each type is primarily intended for a particular duty, all are able to perform other duties to some extent. For the effect of a wind on the distance which an airplane can cover:

On a circular course or on any flight where the machine has to return to its starting point a wind must always be prejudicial. It should also be remembered that a wind at 6,000 feet will be roughly twice as strong as it is on the ground, and that its direction will usually change about 20 degrees clockwise.

The equivalent of at least half an hour's flying must be deducted from the rated gasoline capacity to allow for climbing and for a small reserve.

An airplane with total gasoline capacity sufficient for $3\frac{1}{2}$ hours at a speed of 75 miles per hour, can, of course, go to a place 112 miles away and return to its starting point, provided there is a dead calm, the available gasoline capacity being counted as sufficient for 3 hours; but if it is ordered to proceed east when there is a wind of 20 m. p. h. blowing from the west-south-west on the ground it will not get so far. At reconnaissance height, the wind will probably be west and 40 miles per hour. The speed on the outward journey will be $75+40=115$ miles an hour. The speed on the homeward journey will be $75-40=35$ m. p. h., *i. e.*, in the ratio of 23 to 7.

In order to find the greatest distance the airplane can go out and still have enough gasoline left to get back to its starting point, the available time for which it can fly must be divided in the proportion of $\frac{7}{30}$ for the outward journey, and $\frac{23}{30}$ for the homeward journey.

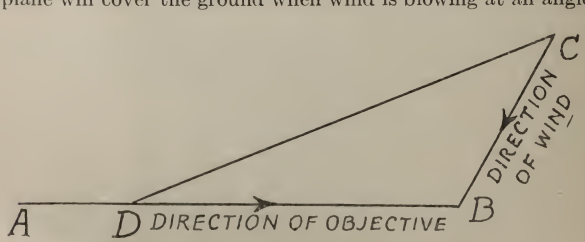
It can, therefore, spend $\frac{7}{30}\times 180=42$ minutes on the former and must reserve 138 minutes for the latter.

The farthest distance the airplane can go is $\frac{115\times 42}{60}=80\frac{1}{2}$ miles.

These figures would be the same if the airplanes were ordered west instead of east.

If the same airplane was ordered to go north or south under the same conditions of wind, the maximum distance it could go would be 95 miles.

A graphic method is the best way of determining the speed with which an airplane will cover the ground when wind is blowing at an angle.



Take a line AB, representing the direction of the objective B from the starting point. Draw a line CB, the direction of which represents the direction of the wind and the length of the wind's strength in miles per hour, on any suitable scale.

With center C and radius CD, equal to the speed of the airplane in a calm, draw an arc of a circle cutting BA in D. Then DB = the speed with which the airplane will cover the ground, and DC is the direction in which it must steer.

By finding in this way the speed on the outward and the homeward journey, the maximum distance to which the airplane can go can be calculated.

2. The duties of airplanes in war may be sub-divided as follows: (*a*) Reconnaissance; (*b*) direction and observation of artillery fire; (*c*) fighting against other aircraft; (*d*) destruction of materiel, and demolitions at vulnerable points on the enemy's communications; (*e*) offensive action against troops on the ground.

3. The number of hours flying per day that can be carried out by any Flying Corps Unit is strictly limited, and may be taken at an average of 10 hours per squadron. It may be increased temporarily in emergencies, but only for short periods. It might be trebled for two days in succession, but in no case for more without entailing very serious loss in efficiency. It is for the commander of the formation to say how the hours available can be best divided between reconnaissance, artillery work, and offensive operations.

The strictest economy must be exercised and every effort made to avoid duplication of work.

4. The most important role of airplanes in war is reconnaissance. A well-trained and efficient air service will enable a commander to form his plans with a fuller knowledge of the situation than will be possible to one whose air service is inadequate to the task which it has to perform.

Aerial reconnaissance differs in many ways from that effected on the ground:

First.—It is very rapid. Airplanes can maintain a speed from 50 to 90 miles per hour, and thus obtain in a few hours information that would require several days to obtain by other means.

Second.—It is not stopped by natural obstacles such as rivers, or by artificial obstacles in the shape of fortresses.

Third.—Can ascertain the movements, position and approximate strength of the enemy's main bodies instead of the mere contour of his covering troops.

Fourth.—It is a comparatively simple matter to bring back the information gained in time for it to be useful.

On the other hand, airplanes can accomplish little or nothing in heavy rain, fog, gales, or darkness, and although they may be able to fly on any given day, they may not be able to do so at any particular time of day. Further, they may sometimes bring back misleading negative information; they cannot remain in continuous touch with the enemy by day and by night, and usually cannot identify individual units.

Hence aviation is a valuable addition to other means of reconnaissance, but does not in any way dispense with the necessity for the latter.

5. Hostile aircraft will be attacked whenever met, in order to prevent the acquisition of information by the enemy, and to gain or retain a moral and material ascendancy in the air. Fighting should be avoided only when the pilot has received instructions to the effect that the same accomplishment of his mission is to be placed before all other considerations, or when he is confident that his reconnaissance has discovered information which it is of paramount importance to his own side to receive without delay.

As in other forms of reconnaissance, information frequently will have to be fought for, and reconnoitering airplanes must always be prepared to fight.

Airplanes constructed and equipped with the primary object of fighting in the air must sometimes be employed to protect those with little offensive power, such as wireless machines. They will also be employed to cut off and destroy hostile and reconnoitering airplanes, or to attack hostile airplanes which are directing artillery fire, in addition to seeking out hostile airplanes in their own lines.

6. The location of targets and the direction of artillery fire is one of the regular functions of airplanes, and a proportion are especially equipped for this purpose.

Aircraft forms a most important factor in enabling artillery to gain superiority of fire over the enemy, especially in trench warfare. The attainment of this will be greatly facilitated if aircraft have established an ascendancy so marked that the enemy is unable to use his airplanes for the observation of the fire of his guns.

7. Airplanes may be employed in the destruction of hostile ammunition and gasoline depots and transport parks. They may also be used to hamper the enemy's operations by demolition of road and railway bridges, and of railway trains. Such action may hinder the movements of reinforcements, ammunition, and supplies, either in a limited area in which a tactical decision is being sought, or at such vulnerable points as the enemy's lines of communication, where interruption of traffic, during a critical period of the campaign, may influence the general situation. Owing to the limitations of the carrying power of aircraft, and the consequent necessity of concentration of effort to ensure adequate material results, such enterprises involve the use of a large number of airplanes.

8. Under certain conditions the moral effect of aircraft against troops on the ground may be very considerable, though the actual effect may be small.

9. Airplanes may be employed to watch and report the movements of friendly troops, and thus keep the staff in close touch with the progress of events than has been previously possible. The great speed of airplanes and the fact of their not being hampered by ordinary obstacles, render them valuable agents for the conveyance of messages or of staff or other officers, provided landing grounds exist. They may also be used for the rapid conveyance of small quantities of ammunition or supplies which may be urgently required at some otherwise inaccessible point.

B. Allotment of Airplanes to Formations.

DISTRIBUTION.

1. A proportion of aircraft is usually retained to work immediately under General Headquarters in order to locate and watch the movements of the enemy's main reserves, for distant reconnaissance on the flanks and beyond the battle area, and for offensive action against vulnerable points on his lines of communication.

2. Wings of the Flying Corps are attached to Army Corps for the purpose of reconnaissance, observation and direction of artillery fire, and for offensive operations. After consultation with the Army Staff, Wing Commanders may detail squadrons or detachments of airplanes to work with Divisions, for the purpose of carrying out local reconanissance and artillery work only.

If any further duties are required of these squadrons or detachments, such as distance reconnaissance or bomb dropping, the question will be decided by the Corps or Detachment Commander after consultation with the Wing Commander.

3. Areas for close reconnaissance by airplanes are allotted to wings by General Officer Commanding, Flying Corps, under instructions from General Headquarters. These areas normally extend in depth about 20 miles to the front and will overlap slightly.

When the front held by an army is altered, the General Officer Commanding, Flying Corps, is empowered to make the necessary adjustments to the boundaries between these areas.

The Commander of each army will instruct his aircraft Commander as to the particular places he wishes reconnoitered and the points to which he wishes particular attention to be paid, but except in emergencies will not order close reconnaissance to be carried out in any area other than his own.

The Aircraft Commander, subject to the approval of the Army Commander, may reconnoiter such additional places inside his close reconnaissance area as he considers desirable. Close reconnaissance required by General Headquarters will be ordered by General Officer Commanding, Flying Corps, from the Wing Commander in whose area the reconnaissance lies.

A similar method will be followed in the case of local reconnaissance, the areas being alloted to squadrons or detachments by the Wing Commanders under instructions from Army Headquarters.

Wing Commanders must keep the Army Corps and Flying Regimental Commander informed of the area for which the Flying Corps units allotted to them ARE RESPONSIBLE.

If the Army Commander desires to use airplanes from squadrons attached to Divisions for some particular reconnaissance, he will issue the necessary orders after consultation with the Wing Commander, who will notify the Division concerned.

If the Corps Commander desires to carry out a reconnaissance outside the area allotted to him, he must refer to the Army Commander.

Upon command of the Army or Corps Commander, the necessary orders for photographic work or bomb dropping will be issued by the Wing or Flying Regimental Commanders.

4. In order that there may be no duplication of work the Army Commander will inform Corps and Division Commanders of the area of reconnaissance for which the Wing or Squadron will be responsible. The detailed allotment of airplanes for this duty, and for observation and direction of artillery fire, will be made by the Commander of the detachment. The Commander of the detachment will report daily to the headquarters of the formation to which his squadron or section is allotted, stating the number of machines he has available.

GENERAL ARRANGEMENTS WHEN THE ARMY IS ON THE MOVE AND DURING AN ENCOUNTER BATTLE.

5. *Prior to Contact With the Enemy Being Obtained.*—When contact with the enemy is improbable it is undesirable to detach airplanes for use with corps or divisional headquarters. Reconnaissance can then be more efficiently carried out under instructions from Army Headquarters than Wing Headquarters and the results communicated to Army Corps and Divisions.

When contact with the enemy is expected or has been obtained, it becomes important that aircraft should work in close cooperation with corps and divisional headquarters, in order to ensure that opportunities, which may arise from the early receipt of information, are not lost owing to delay.

6. *When the Enemy is Encountered.*—When the enemy is encountered, Corps and Divisional Commanders have to decide on their plans of action in accordance with the orders which they have received, and such information as may be in their possession. It will be of great advantage if, at this stage, the information obtained from other sources can be supplemented directly by that obtained by aerial reconnaissance.

An initial advantage may be gained if early information can be obtained as to the enemy's dispositions, more particularly when this information is of such a nature as to allow artillery fire to be brought to bear on his artillery positions and on formed bodies, either before deployment or while in reserve. The issue of wireless receiving sets and electric signalling lamps to artillery and other units will enable this information to be sent rapidly to those concerned.

Detachments of the Flying Corps will, for this purpose, be allotted temporarily to Corps or Divisions as may be possible or desirable. During a retirement it may be necessary to withdraw all detachments from corps and divisions, in order that movements of all airplanes may be controlled by the Wing Commander.

Whether air service be assigned to armies, corps, or divisions, it should be clearly understood that the commander of the troops is responsible for, and must command, all agencies entrusted to him by higher authority for the purpose of accomplishing the military ends with which he may be charged.

7. *Position of Landing Grounds.*—The Aircraft Commander must keep informed of the probable movement of the formation to which his detachment is allotted, and should receive a copy of their operation orders.

During an advance an officer of a detachment will be detailed to accompany the advance guard, in order to reconnoiter successive landing grounds. He will report to headquarters of the formation, the position of the landing ground, or landing grounds, available. Headquarters will inform the Aircraft Commander when the report center is to be moved and will detail which new landing ground is to be used. As soon as Corps or Divisional Headquarters or report center is settled, a landing ground will be selected as near as possible to it.

The Aircraft Commander will have the ground marked as a landing ground, and arrange for any improvements to be carried out, asking for the assistance of the Engineer Corps when necessary.

When landing grounds and report centers have to be some distance apart, the latter may be marked, to denote that messages may be signalled or dropped there. In this case the staff must arrange for the provision of an observer and orderlies at the report center.

It is the duty of the Aircraft Commanders to ensure that the signal units of the corps or division are kept informed of the position of the landing grounds in use, so that a rapid system of communication may be arranged between them and the report center.

8. *Movement of Transport.*—Squadrons or detachments detailed to accompany cavalry entrusted with a special message should have all their transport with them, unless this is precluded by the nature of the

mission entrusted to the cavalry. Squadrons under General Headquarters, which are pushed forward to the protective troops, must be accompanied by their light trucks and only such of the heavy trucks as are absolutely necessary for their efficient maintenance. Additional vehicles, with spares, etc., can be sent up from the rear and returned when necessary, moving with the supply column.

The movements of the transport of the squadrons with armies, corps or divisions, present less difficulty. The successive landing places will be located in the rear of other arms, and the greater part of their transport can therefore follow in rear of the divisions. The usual method of procedure, subject to the control of the Staff of the formation concerned, will be as follows: The Aircraft Commander will receive orders from the headquarters to which his unit is attached, defining the area in which his billet or bivouac is to be situated. He will then select the landing ground in the area covered by protective or other troops and inform the General Staff in order that arrangement for linking it up to the headquarters may be made by the Signal Corps. The light trucks with a few mechanics, essential spares, gasoline and lubricants will be sent forward as soon as possible. It will often be possible to get these past the division during a long halt, but no attempt should be made to pass troops on the move except in cases of necessity. All serviceable airplanes that are not being employed will be sent to the new landing place, the Squadron Commander moving with them. Should any aircraft be flying when the forward move of the others is made, one or more light trucks should remain at the old landing place until they return, when both can move to the new ground. The heavy trucks will, as a general principle, be brought forward to the landing place as soon as possible, in order that repairs may not be unnecessarily delayed, but circumstances may necessitate their being kept in rear until dark, so as to leave the roads free. It will facilitate the actual work of repair if the landing places are moved as seldom as possible.

Temporary landing places will often be arranged close to the headquarters of armies and divisions in order to facilitate communication, but no attempt must be made to bring heavy trucks up to such points until the roads to the rear of them are clear of troops.

C. Reconnaissance.

TYPES OF RECONNAISSANCE.

1. There are three types of airplane reconnaissance:

(*a*) *Distant Reconnaissances.*—The object of distant reconnaissances is to obtain information in areas beyond those reconnoitered by wings with armies. Reconnaissances of this kind will, as a rule, be carried out by airplanes sent out direct from the wing at Flying Corps Headquarters, under orders from General Headquarters. Distant reconnaissances will only rarely be required by armies.

The possibility of carrying out distant reconnaissances depends very much on the weather. For this reason, or because of the suitability of a particular landing ground, it may be found desirable to station airplanes from the wing at Flying Corps Headquarters in the area of one of the armies.

As a rule, such a detachment will remain under the direct order of the wing at Flying Corps Headquarters, but it may be temporarily attached

for administrative purposes to the wing with the army. As an alternative it may be found necessary on occasions to call upon a wing with an army to carry out a particular distant reconnaissance.

(*b*) *Close Reconnaissance for Armies.*—This type has usually been called "Tactical Reconnaissance," but the use of the term is misleading as the information obtained may be either tactical or strategical. A "Close Reconnaissance" may cover an area extending to some 20 miles to the front, and overlapping a little the reconnaissances on either side.

(*c*) *Local Reconnaissance, i. e.*, in the immediate front of troops.—The particular uses of such reconnaissance are the location of the enemy's defenses, gun positions or reserves. The area to be covered by such reconnaissance will usually extend to 8 or 9 miles in front of the line and slightly overlap the reconnaissance on either side.

2. The difficulties to be dealt with and the results to be expected from the air reconnaissance vary according as the opposing forces are on the move or stationary. In the former case the task is simple; troops in column of route are easily seen, they will be moving in definite formed bodies and their strength can be gauged with fair accuracy.

As the opposing forces become stationary there may be three phases: (*a*) When most of the movements leading to the battle have ceased; (*b*) when the forces have begun to dig themselves in; (*c*) when both sides are strongly entrenched.

3. Observation of the commencement of a battle is difficult, for, although the infantry and the guns of the opposing forces have not had time to entrench, all important movements have ceased or take place so slowly as to escape notice; frequently neither troops nor guns are visible, and reserves are concealed in woods or villages. The only indication available for an observer may, therefore, be a line of bursting shells.

The most favorable moment for the observer to locate the position of the opposing front, and the approximate development of the flanks, is when the forces have begun to entrench.

At this period the trenches have not had time to become complicated, but the line is fairly marked and can be distinguished from the front of our own forces.

When both sides are fully entrenched the same observer should, if possible, search the same area daily as he then gets to know it thoroughly and is better able to detect variations in the trenches, etc. Photography will be largely resorted to, in order that accurate information may be obtained as to the enemy's defensive work. Very little movement will be seen except possibly on railways, as what takes place will probably be carried out by night.

The fact of movement having taken place can, however, often be deduced from the increase or diminution of road and railway transport at different places, and when armies are stationary both close and distant reconnaissance are undertaken largely with this object.

4. Reconnaissances, whether distant, close or local, may be either "Line" or "Area." A line reconnaissance is one in which the observer is instructed to fly over a certain line, points on the map being indicated over which he is to pass. Area reconnaissances are those in which the whole of the area must be observed in the manner most convenient to the observer. In this case the area is usually covered backwards and forwards until the observer is satisfied that he has obtained all the information of importance about the enemy in this area. Area reconnaissances require a good deal of time, and cannot be undertaken at

very great distance from the front. They are not usually necessary unless particularly detailed information is required, and the more the size of the area is limited, the better the result that will be obtained.

When a reconnaissance of an area is required, at least four clearly marked points, such as towns or cross-roads, should be given to the observer and the pilot, so as to define the country they are to work over.

In some cases airplanes may be allotted tasks such as ascertaining whether a definite body of troops is moving, and if so, in what direction. In such cases the route to be followed must often be left to the discretion of the observer and cannot be ordered beforehand.

5. When searching large areas for troops it will be impossible to search every road without a large number of separate reconnaissances. The general direction of the enemy's line of advance having been fixed, however, simple calculations in time and space with careful study of the map, will enable a large saving to be effected in the number of aircraft that need be despatched.

In many cases there are certain definite road junctions which a column must pass if moving along any one of three or four different roads, and thus an aircraft following one of the roads and passing over the junction could cover them all. Other roads again can be eliminated because they are circuitous or lead to a road known to be occupied already by another column.

It may sometimes be advisable for aircraft to move at right angles to, rather than along, the enemy's line of movement. Thus, supposing a river runs across his line of advance, so long as airplanes move along it at intervals not exceeding four hours and are able to observe all bridges, it can be known for certain that no force as strong as a division can cross the river by any one bridge without being observed.

In such cases the exact time at which an airplane is to arive over a certain spot will be important.

6. As the situation develops and the hostile units become identified, aircraft may be employed to keep track of each one and to mark down its position every few hours.

7. When searching for troops whose billeting or bivouac areas the previous night were known, the principles in paragraph 5 may be followed. An airplane can be sent along any well defined line at right angles to the enemy's line of advance, so as to cross all the roads by which he can be moving. A second airplane is despatched at the same time along a line parallel to the first and 4 to 10 miles distant from it, this interval varying with the strength of the enemy, and the number of roads available on which the minimum possible length of his columns will depend. In this manner two airplanes can cover a large number of roads, and should be certain of hitting off either the head or tail of a column moving along any one of them. If considered necessary a third or even fourth parallel line could be reconnoitered.

8. When locating the billets of a force which was seen earlier in the day, a rough idea as to its probable position can be obtained fron consideration as to the maximum distance the troops can have marched. Except when a battle is imminent troops will usually be billeted in depth, occupying roughly as much space as they would on the line of march.

When going out in the morning to reconnoiter troops located in billet or bivouac the previous evening, the observer should be informed whether, in the event of their still being in the same place, he is to return at once or remain as long as possible in observation to see them off.

9. Squadron Commanders will allot a serial number to each reconnaissance carried out by their squadron. The first reconnaissance in each month will be numbered No. 1, and the numbering be continued consecutively throughout the month.

Reports are made out in triplicate, and will be rendered as follows:

(*a*) Reconnaissances ordered by Flying Corps Headquarters; 2 copies to Flying Corps Headquarters, 1 copy retained by the wing.

(*b*) Army reconnaissances: 1 copy to Army Headquarters, 1 copy to Flying Corps Headquarters for transmission to General Headquarters, 1 copy retained by the wing.

(*c*) Other reconnaissances: 1 copy to the formation by whom the reconnaissance was ordered, 1 copy to the headquarters of the army with which the wing is working, 1 copy retained by the wing.

They will normally be sent through the Aircraft Commander who details the reconnaissance, and the observer should, if possible, bring in his report personally.

Thus in the case of close reconnaissance for an army, the report will be sent through the Wing Commander to the Intelligence branch of the Army Staff.

The distribution of information is not part of the duties of the Flying Corps.

ORDERS FOR RECONNAISSANCE.

10. The Aircraft Commander will receive from the General Staff details of the information required. He will decide in consultation with the General Staff whether it is possible to carry out all the reconnaissances necessary to obtain this information with the airplanes at his disposal, and, if not, what items of the information required can best be obtained by aerial reconnaissance. He must then apportion the work to the squadrons or sections at his disposal in such a manner to ensure that the distances to be covered are reduced as much as possible, that squadrons or sections are detailed for tasks which are most suitable for the types of airplanes they possess, and that they work as much as possible over the same area from day to day.

11. The instructions by the General Staff should be framed in the same manner as those issued to the commander of a body of cavalry employed on a special mission; Aircraft Commanders should be given certain definite questions to answer and particular areas to search, and they should be allowed a free hand as to the manner in which they will carry out their tasks. Aircraft Commanders should be given a copy of the instructions issued to the cavalry or other advanced troops, and the fullest information as to what is known of the enemy; close touch should always be maintained between them and the intelligence branch of the General Staff. Whenever possible, operation orders should include information concerning landing places and the movement of aircraft transport in order to facilitate cooperation and protection.

12. The orders of the Flying Corps Commander and other officers of the Flying Corps should include: (*a*) information as to the enemy and of our own advanced troops; (*b*) the object of the reconnaissance; (*c*) route to be followed if general information is required (if certain definite information is required, the route should not be given); (*d*) special points to be watched for; (*e*) time of starting if necessary; (*f*) method of reporting and where to send messages; (*g*) procedure to adopt in case of breakdown; (*h*) what other aircraft are reconnoitering the same objective or on the flanks of the route detailed.

13. In winter an early start is advisable; wind and weather are, as a rule, at their best just after sunrise. In the summer, generally speaking, the ground should be left in time to ensure being over the enemy between 6.30 and 7.30 a. m. Maps, clothing, etc., will be prepared over night, and will always be at hand during the daytime. A reconnaissance should be able to start within 6 minutes of being ordered, but if time is available it is always advisable to study closely the map of the area to be reported upon. If a reconnaissance is made too early it may prove abortive, owing to the enemy not being on the move.

CONTACT PATROL.

A contact patrol may be defined as a special tactical reconnaissance carried out during the progress of an attack.

1. *Object.*—Contact patrol work by airplanes is designed (*a*) to keep headquarters of formations informed as to the progress of their troops during an attack; (*b*) to report on the positions of the enemy opposing the advance, the movements of his immediate reserves and the state of his defenses; (*c*) to transmit messages from the troops engaged to the headquarters of their formation; (*d*) to report on the state of enemy trenches, the position of any new trenches, whether there is wire and whether it is damaged or undamaged, and the position of main enemy tracks leading to their trenches.

Contact patrols supplement but in no way take the place of other systems of communication. They are, however, rapidly developing into the most important channel of communication between the battlefield and Divisional and Corps Headquarters, as they are in the most advantageous position for collecting the necessary information quickly and accurately and the most reliable means of conveying that information to Corps and Divisional Headquarters without interference or delay. Other means of communication between the battlefield and Corps Headquarters are by telephone and messengers, but once the attack has started, telephonic communication is greatly interfered with owing to lines between being cut by the enemy's barrage and the difficulty of repairing the wires under heavy shell fire, while messengers cannot be depended on, owing to the liability of their being put out of action.

Observers must be fully informed as to the plan of attack, the disposition of the troops with whom they are working, and their objectives. Before going up, the observer should always, if possible, visit the division, or, if the operation is a small one, the brigade concerned, in order to obtain all the detailed information possible. Operation orders frequently do not contain points that are of great importance to Contact Patrol Pilots and Observers to know, such as where the Infantry are to take off for the attack, and owing to the irregularity of the battle lines points such as this are essential to know.

Pilots and observers should learn all operation orders, by heart also the positions of headquarters of all divisions and brigades in their Corps area. Notes on such points or notes on operation orders must never be taken up in the air owing to the danger of their falling into the enemy's hands if the machine is forced to land behind the enemy's lines. Pilots and observers should keep in touch with the Brigadier General Staff of their Corps, and so learn the points of information that he is most anxious to obtain. Before an important attack pilots and observers

must carefully prepare their skeleton sketch maps by comparing them with the latest air photographs; any new sap, trench, etc., not appearing in their skeleton maps must be carefully marked in. When flying over ground that is all torn up by shell fire, it is extremely difficult to fix positions accurately and every little detail is of assistance in doing this. The Contact Patrol should synchronise his watch with the Staff, so that he may know exactly when to look for the attack to commence. As much notice as possible should be given to the squadron concerned when a Contact Patrol is required in order that the observer may have time to make these visits.

2. *Recognition of Airplanes.*—Airplanes detailed for contact patrol work must have special markings which differ according to the Corps with which they are working. In some Corps they have a black flag painted under one wing tip, in others they carry black streamers fixed to the rear struts and so on. The special markings of the machines working with them should be known to all ranks of the Corps. They will, in addition, carry a Klaxon horn and Very's lights for the purpose of making themselves known and to answer signals received from the ground. Infantry may, as a general rule, expect to see their contact patrol machine vertically above our own and the enemy's trenches.

3. *Information Sent to Our Artillery.*—Airplanes on contact patrol must not be called upon to report regarding hostile batteries, nor to check the fire of our Artillery, which is the duty of the machines working with the Artillery. From the position from which they work they are, however, very well placed to keep our Artillery informed as to the movements of the enemy in immediate contact with our Infantry. Contact patrol machines should watch especially for movements of immediate reserves, massing of troops for counter-attack, minenwerfers, machine guns and strong points holding up our advance, and targets of such nature. Wireless will only be used by contact patrol airplanes for the purpose of sending down targets to our Artillery. Such targets will be sent down under the Zone Call System as used by Artillery machines. Hostile batteries will normally be dealt with by the Artillery machines.

THE ZONE CALL SYSTEM.

For the purpose of zone calls the big lettered square is divided into four parts. In the case of the maps where the big lettered squares are divided into 36 numbered squares, each of the 4 sub-divisions for area or zones would be a square containing 9 squares. These four sub-division are called A, B, C, D.

A sub-division would contain the squares 1, 2, 3–7, 8, 9–13, 14, 15.
B zone would contain the squares 4, 5, 6–11, 11, 12–16, 17, 18.
C zone would contain the squares 19, 20, 21–25, 26, 27–31, 32, 33.
D zone would contain the squares 22, 23, 24–28, 29, 30–34, 35, 36.

The zone call for any map position is the large letter of that square followed by the letter of the particular zone, *e. g.*, D8 A9.2, zone call is D A; D17 B5.8, zone call is D B and so on.

Supposing that the Contact Patrol machine observes a body of enemy infantry massing in the open and decides that, taking all the circumstances of the case into consideration, it is of sufficient importance to justify the L L emergency call.

The observer takes the approximate center point of the position where the enemy are massing and sends the L L three or four times at least, fol-

lowed by the zone also sent three or four times, and then FAN MAS—Infantry Massing, followed by the map square and co-ordinate number of the enemy.

e. g., 500 Infantry are seen massing at J6 A8.5. The message sent down would be: LL,LL,LL,LL, JB,JB,JB,JB; FAN MAS; J6 A8.5; 500.

Every battery whose zone of fire included that point would leave any target that it was engaged with and concentrate its fire on the target mentioned in the emergency message.

If a contact patrol machine observed enemy infantry massing in the trenches it would send down the zone call at least 3 or 4 times, followed by FAN MAS followed by the pin points of the two flanks, *e. g.*, enemy infantry are observed massing in a trench from J16 A5.6 to J16 B8.1.

The message would be sent: JB,JB,JB,JB, FAN MAS J16 A5.6 J16 B8.1.

This message would be received by all artillery groups, and the batteries to deal with such a target would be detailed by the Chief Artillery Officer of the Division.

In the event of a contact patrol machine observing a column of enemy infantry it would send down the zone call 3 or 4 times followed by FAN COL and the map position and co-ordinates of the head of the column and the direction in which the column was marching; *e. g.*, column of enemy infantry marching NW head of column K3c 9.1.

Message would be sent: KA,KA,KA,KA, FAN COL K3c 4.5. NW.

When sending down the position of the head of the column of enemy infantry, the machine must send down the pin point of the position which he reckons will have been reached by the column when the artillery are ready to fire. After sending the message the machine may send MQ (wait), and then when the head of the column has reached the pin point which was sent down, the observer should send GO. (Fire at your own time), *e. g.*, it takes 5 minutes to turn on Artillery from time call is first sent down.

In 5 minutes the infantry marching at 3 miles per hour would have covered 440 yards. Therefore K3c 4.5 NW would be the position which the head of the column would have reached by time that the Artillery would be ready to fire.

If several batteries engage the target, and the general fire effect is good, corrections should not be sent but it is a good thing to send down a GO occasionally as that will indicate that the target is being satisfactorily dealt with.

4. *Methods of Communication between Infantry and Airplanes.*—Contact patrol airplanes receive signals from: (*a*) Attacking Infantry; (*b*) Battalion and Brigade Headquarters.

Attacking Infantry signal to the airplane by means of flares. Flares will be lit (1) by previous arrangement; (2) at specified times; (3) at specified places.

The former is, as a rule, the preferable plan.

The approximate hours at which the flares will be lit should be laid down in orders. At these hours the Infantry will be on the look out and will light their flares when their airplane calls for them by Klaxon horn. About half an hour after the objective is expected to be reached has been found a suitable time.

When the attack has started, the advance of the Infantry must be carefully watched. At the time at which the first objective should have

been reached, the signal "Where are you" should be sent down either by firing Very's lights or sending down a succession of hoots on the Klaxon. To this the Infantry should reply by lighting flares or by lamp, and their position must be immediately marked down on a sketch map. The pilot and observer should then look just behind the line for the position of Regimental Headquarters so as to take any message they may wish to signal to the machine by shutter or lamp.

When marking down the position of our Infantry the utmost care must be taken to do so with extreme accuracy, for any mistake may result in their getting shelled by our own artillery.

Flare will be lit without previous arrangement (*a*) when called for by the airplane by Klaxon horn; (*b*) on the initiative of local Commanders, who may wish to make their position known.

Flares should only be lit by the order of local Commanders when the airplane working with their formation is flying in their vicinity. When flares are called for by the airplane it is important that they should be lit by the most advanced troops. Bodies of troops in rear will often light flares, thinking that they are the most advanced, but this will not prevent the location of the front line, provided flares are also lit there. Flares are used for the same purpose as mirrors; they should be lit in batches of 3 and are then very visible from the air. Flares can be seen if lit at the bottom of trenches, or in shell holes, but care must be taken that there is no obstruction between the flare and the airplane. At least two flares per man should be carried by troops in the attack. The signal by Klaxon horn to call for flares will be a succession of A's. If the Infantry cannot reply at once they should await a repetition of the signal before lighting their flares, otherwise they may be lit when the observer is not in a position to see them.

(B) Regimental and Brigade Headquarters indicate their position and identity to the airplane by means of ground signal sheets and strips. Ground signal sheets (Regimental Headquarters, semi-circular ground signal sheet with letters of battalion call, *e. g.*, AL; Brigade Headquarters, three-quarters circle ground signal sheet with letters of brigade call, *e. g.*, PN) are laid on the ground at the headquarters concerned to indicate its position, while its identity is disclosed by the code letters of the regiment or brigade, made by ground signal strips, laid alongside the sheet, or sent on the panel or lamp, if strips are not available. Sheets and strips should be put out as soon as the headquarters is established and left out until it moves.

(C) Regiment and Brigade Headquarters send messages to the airplane by means of (*a*) ground signal panel; (*b*) lamp.

Ground signal strips will not be used for the purpose.

Complicated systems of communication are bound to break down in battle, and signals sent by the above means will therefore be confined to those given as follows:

BY BRIGADE OR BATTALION HEADQUARTERS.

By lamp or signalling panel.	*Meaning.*	*Answer by airplane by lamp or Klaxon.*
Regiment or Brigade call	Headquarters are here	T
Succession of B's	Enemy are retiring at	T
F's	Enemy offering strong resistance at	T
G's	Further bombardment required	T
H's	Lengthen range	T
J's	Raise barrage	T
K's	Lower barrage	T
O's	Barrage wanted	T
P's	Reinforcements wanted	T
N's	Short of ammunition	T
W's	Short of water	T
Y's	Short of grenades	T
X's	Held up by M. G. fire	T
Z's	Held up by wire	T
O. K.		T

Signals will be preceded by regiment or brigade call letter if strips have not been put out. The map location of the point of the line to which reference is made will be given if necessary by the clock code, the position of the sender being considered as the center of the clock face, and the hour 12 being always taken as pointing due north. The distance in yards from the point it is desired to describe will be given by a letter of the alphabet, A representing 50 yards, B 100 yards, C 200 yards and so on. The direction will be given by the hour on the imaginary clock face; *e. g.*, if it were necessary to ask for the range to be lengthened at a point 400 yards north-west of Regiment Headquarters, the message would be HHHE 10, HHH being acknowledged by T, and the whole message by the code letters of the sender followed by RD.

Distances of 150, 250, 350 yards, etc., will be given a two-letter signal, *e. g.*, BA =150, CA =250, DA =350.

Headquarters will indicate that they have a message for the airplane by displaying the white side of their ground signal, panel or by shining their lamp on the airplane. When an airplane is ready to receive a message it will send the code letters of the Headquarters concerned, followed by the letter G, by Klaxon or lamp, using the Morse code. Each word or code letter of a message from the ground will be answered by the airplane by the general answer T, and the receipt of the message will be acknowledged by the code letters of the sender followed by RD (received).

Ground signal sheets, strips or panels must be carefully sited in order to give the airplane observer a dark background if possible. In signalling to an airplane from the ground it is essential that (1) signallers should know when the airplane is in position to receive and when it is not so; (2) signalling should be slow, and particular attention should be paid to the timing and to correct formation of letters; (3) signallers on the ground should have patience and continue sending until their signals are acknowledged.

5. *Methods of Communication between Airplane and Infantry.*—Contact patrol airplanes communicate with the attacking Infantry by means of Klaxon horns, using one signal only—namely, a succession of A's,

meaning "light flares." If the Klaxon fails to act, or if no reply is received, the airplane will fire a white light, indicating a call for flares. They communicate with Headquarters of Regiments and Brigades by means of—

(*a*) Klaxon horns, (*b*) Lamps (using the Morse code in both cases).

6. *Methods of Communication between Airplanes and Headquarters of Corps and Divisions.*—Airplanes communicate with the Headquarters of corps and divisions by dropping message bags. The Contact Patrol machine should be at a height of 200 feet when it arrives over the Corps or Division dropping center, and should notify its intention of dropping a message bag by sending down blasts on its Klaxon horn. After dropping the message bag the machine should circle round the reporting center until Corps or Division Headquarters signal up by lamp that the message is received. If this is not signalled up after a couple of minutes, another message bag containing the message should be dropped.

Observers should be provided with tracings on a suitable scale and showing all known trenches, on which the positions reached by our own troops will be marked as follows:

Flares, ...

Regimental Headquarters, with regimental call letters.

Brigade Headquarters, with brigade call letters.

When necessary, the tracing should be supplemented by a message. On reaching the ground the observer will report personally or by telephone to the Headquarters concerned.

7. In addition to establishing communication between Infantry and the Headquarters of formations, Contact Patrol airplanes may be employed to report on the enemy's dispositions and defences both before and during an attack. Contact Patrols must keep a keen lookout for any of our Infantry that may have advanced too far and so be in danger of being cut up or cut off. This information must immediately be dropped in a message bag. A very important part of the work is to watch for any concentration of enemy reserves.

Prior to an attack they are able to keep the Command constantly informed as to the progress and results of the Artillery bombardment, while after an attack they can discover the enemy's fresh dispositions and sometimes his strength at various points. In this case also observers must be given all available information by the Staff concerned before starting.

Commanders and Staffs when giving orders for such reconnaissances must fully consider the risks run by pilots and observers in carrying them out. At an altitude of 1,500 feet or less an airplane is almost certain to be hit by rifle and machine gun fire from the ground, unless the enemy is fully occupied in fighting. Conditions will arise in which these dangers should and must be run, but it must be borne in mind that the loss of one or two good pilots or observers who know their ground impairs the value and efficiency of squadrons for a considerable time, and is only justified by the chance of obtaining information of really first-class importance. When giving orders the degree of importance attached by the Commander to the information required should be explained to the observers, who will then be able to judge to some extent the risks which they are justified in incurring.

From 3,000 feet:—An attack can be followed; bombing can be seen; state of trenches can be reported upon, as to whether they have been badly damaged by bombardment or not; trench mortar emplacements can sometimes be seen; tracks can be seen.

From 2,500 feet:—Men massed in trenches can be seen; it can sometimes be seen whether a trench is revetted or not.

From 2,000 feet:—Wire in a good light (but not its condition); overhead traverses; sandbags; comparative width of trench.

From 1,500 feet:—Dugout entrances; comparative depth of trench; men making signals, such as waving their helmets.

From 1,000 feet or under our own troops can be distinguished from those of the enemy.

COOPERATION OF AIRCRAFT WITH ARTILLERY.

General.

1. *Importance of Artillery.*—The strength of the defense in modern warfare due to the universal use of the spade and barbed wire and to the great increase in the number of machine guns, has made the success of the infantry attack more dependent than ever on efficient artillery preparation and support.

Accurate artillery fire is dependent on good observation; as the range of modern weapons has increased, so has the need for airplane observation on account of the increased number of targets which can be engaged at a greater distance behind the enemy's lines.

2. *Means of Observation from the Air.*—The means of observation available from the air are airplanes and balloons. For accurate observation at long range on a small target, such as a hostile battery, observation by an airplane, which can fly vertically above the target, is essential. Balloons, owing to their vulnerability, have to work from beyond the range of most of the enemy's artillery, and are, therefore, most usefully employed in observing fire on targets at short range, such as trench junctions or batteries in forward positions, or on those of greater extent, such as villages, strong points, or transport and troops on the move.

3. *Classification of Artillery.*—Under varying conditions, the artillery brought into the field may include all types of guns and howitzers up to those of the heaviest nature. The various natures may be classified roughly as follows:

(1) Field Guns (3-inch): These are primarily employed in barrage fire, repelling attacks in the open, raking communications and wire cutting. They are also employed to assist in counter-battery work against batteries within their range.

(2) Medium Guns (4.7 inch): Chiefly employed in raking communications, and forming a barrage beyond the range of the field guns; also in counter-battery work, especially for neutralization fire.

(3) Heavy Guns (6-inch and up): These are used against villages, railway stations, camps, etc., which are beyond the range of all other artillery. They are also employed against observation stations such as chimneys and church towers. They may also be employed for long range counter-battery work.

(4) Medium Howitzers (6-inch): Used for trench bombardments and counter-battery work and against troops entrenched.

(5) Heavy Howitzers (8 and 9.5-inch): The principal rôles of these weapons are counter-battery work against batteries provided with good cover and the destruction of strong defenses.

(6) Super-heavy Howitzers (12 and 16-inch): Destruction of specially strong defenses, bridges, etc. The 12-inch howitzer is also used with great effect for counter-battery work.

N. B.—A shell fired from a gun has a lesser angle of descent and a greater remaining velocity than one fired from a howitzer; the 50 per cent length zone is greater in the case of a gun, but the 50 per cent breadth zone of a gun is less than that of a howitzer.

4. *Organization of Artillery.*—The artillery is normally divided into Divisional and Corps Artillery. The heaviest classes of guns and howitzers may be attached to armies, as reserves.

Divisional Artillery consists of 3-inch guns and 6-inch howitzers. It is under the command of the Brigade Commander of the Artillery of the Division, and is organized for administrative purposes into two 2-battalion and one 3-battalion regiments (the battalions of the 3-battalion regiment consisting each of 2 batteries of 6-inch howitzers).

The Corps Artillery is under the General Commanding the Artillery of the Corps, and is organized into a brigade of three regiments (one of 4.7-inch guns, one of 6-inch guns, and one of 8-inch or 9.5-inch howitzers). The Corps Artillery is charged primarily with counter-battery work and the destruction of particularly strong points.

5. *Allotment of Front.*—The front of an army is allotted to the various corps by Army Headquarters, and each corps is made responsible for a certain area as regards counter-battery work. This is known as the corps counter-battery area, and is the area over which the corps squadron, Flying Corps, operates. For observation purposes the corps counter-battery area is usually divided into two or three detachment areas, according to its size.

When there are two detachment counter-battery areas two detachments are detailed to specialize in counter-battery work with the heavy batteries allotted for that purpose. The third detachment is then made responsible for the information concerning the trenches on the whole corps front and for registration work with Divisional and Corps Artillery. This arrangement must be considered as elastic, and sections may be required to reenforce each other as circumstances arise.

When the corps counter-battery area is divided into detachment areas each detachment is made responsible for a section of the trenches and for all registration work over the detachment area in addition to its counter-battery work. The division into two detachment counter-battery areas is usually the best.

The Artillery Commander allots counter-batteries firing into the detachment area for work with each detachment. Observers specialize as regards their own areas and batteries, but considerable elasticity as regards firing into neighboring detachment areas is essential, and the same applied to corps and even to army counter-battery areas.

Work Required of the Artillery.

6. *Tasks of the Artillery.*—The work required of the Artillery may be broadly divided as follows:

(*a*) Barrage fire and attack of targets in the open.

(*b*) Bombardment.

(*c*) Counter-battery work.

7. *Barrage Fire and the Attack of Targets in the Open.*—This is the work of principally light and to some extent medium guns. Airplane cooperation is for the most part confined to locating targets and reporting them immediately to the artillery concerned. In the case of barrage fire batteries may be previously registered by airplane observation on the front they cover, but it is not possible to carry out any deliberate ranging from the air when the barrage is being made. Deliberate ranging is the exception, too, when engaging targets in the open, partly because they are generally of a fleeting nature and partly because the fire of several batteries is usually concentrated on such targets and the observation required for deliberate ranging is not possible.

8. *Bombardment.*—This is the particular rôle of howitzers of all natures, though guns may also be employed with H. E., particularly against vertical targets such as breastworks, barricades, walls and houses, and for enfilade fire. To achieve an effective bombardment great accuracy of fire is essential.

All weapons, especially heavy howitzers, must check their ranges daily before beginning to bombard either on their datum points or on their targets. If observation of targets from the ground is not possible, batteries should be registered on them by means of airplane observation, and in all cases the more that airplanes can be used to check and correct ranging the better. Registration by heavy howitzers previous to the first day of bombardment is of little, if any, value. Useful results may be obtained from aerial observation during the actual bombardment of a trench by heavy howitzer batteries. The observer must, however, be provided with a map showing the task allotted to the various batteries for which observation is required. He is then able to send corrections on any particular sections of trench line direct to the mast of the battery dealing with it.

9. *Value of Counter-Battery Work.*—Good counter-battery work is an essential factor of success. Unless the enemy's batteries are discovered and destroyed not only will his barrage fire render the capture of an objective difficult and costly, but his subsequent bombardments may make its retention impossible. Successful counter-battery work depends upon (1) good organization; (2) the allotment of sufficient artillery of suitable nature; (3) efficient observation; (4) close personal touch between Artillery and Flying Corps.

10. *Natures of Counter-Battery Work.*—Counter-battery work is of two kinds:

(*a*) Neutralization.

(*b*) Destruction.

Neutralization is a temporary measure that can be suitably employed in connection with a definite operation, extending over a limited period of time, *i. e.*, during an attack. It is the normal taks of the medium guns, assisted by the divisional artillery when available. Medium howitzers, if available, may also be usefully employed.

Destruction is the essence of counter-battery work and necessitates the use of heavy howitzers and sometimes heavy guns. A proportion of heavy howitzers should be detailed for this work; where circumstances allow, they are sited well forward in positions where then can reach the enemy's artillery employed on barrage and bombardment. Such positions are not suitable for trench bombardment owing to the comparative inaccuracy of heavy howitzers at short ranges. At the same time it must always be left to the discretion of the Artillery Com-

mander concerned to employ any proportion of his artillery on the most important task of the moment.

Owing to the limited number of machines that can be maintained in the air at one time, counter-battery work in order to be effective must be continuous, and every hour of good flying weather should be utilized for destructive fire. No number of batteries allotted for counter-battery work on one particular day will make up for the lack of sufficient batteries on previous days. Constant changes in the allotment of batteries render close touch impossible between the Artillery and Flying Corps.

Duties of Flying Corps in Counter-Battery Work.

11. *General.*—The duties of Flying Corps pilots and observers employed on counter-battery work are two-fold, viz:—(1) Location of the enemy's batteries; (2) observation of fire.

12. *Location of Targets.*—At least one machine should be up in every corps counter-battery area during the hours of daylight, whenever flying is possible, as an artillery patrol to locate targets. If the amount of work on hand admits, it is preferable to detail separate machines for this duty and for that of ranging batteries, but during a battle the duties will usually have to be combined, as described below.

A machine employed on this Artillery Patrol duty may carry out observation of fire, if a hostile battery is seen in action, but it must be remembered that information secured by reconnaissance may be of greater value to the corps than stopping the fire of a single hostile battery. Even when low flying is possible much useful work can be done by Artillery Patrols working from behind their own troops, especially in spotting flashes which are often more easily seen on a dull day, and in reconnaissance of the enemy's trenches.

The duties of an Artillery Patrol are (1) to locate new hostile batteries, and report those seen active; (2) to reconnoiter all known hostile battery positions, especially those roughly located or reported from other sources, and to fix their exact positions if possible; (3) to observe fire, if so ordered, on hostile batteries seen active; (4) to locate new trenches, machine gun emplacements, and hostile works generally; (5) to record any movements seen on roads or railways and to send them down to the artillery within range.

The Squadron Recording Officer will keep a list of points on which he requires further information; he should always be consulted before a patrol goes up. Pilots and observers must be kept fully informed by him as to the latest information concerning their corps and flight areas. For the location of enemy's batteries other means may also be employed, namely: (*a*) Artillery observation from posts on the ground; (*b*) cross bearings by survey posts provided with the necessary instruments; (*c*) balloons; (*d*) sound ranging; (*e*) aerial photography.

Good results can only be obtained by exploiting all the available means to the fullest extent, and by the careful collation and minute study of the results of each. This work is primarily the duty of the Artillery Intelligence, but the results of aerial observation and photography must also be kept and closely studied by the Corps Squadrons. Both the Artillery and the Flying Corps should keep a book in which each hostile battery is entered on a separate page when first located. Subsequent history of the battery, *i. e.*, when engaged, when active,

etc., together with an air photograph (or a record of its number) on which the battery will be found, will be kept up to date by an officer specially detailed for this duty. In a squadron this will be the duty of the Squadron Recording Officer who will, whenever possible, personally interview pilots and observers on their return from a shoot. The counter-battery commander will apply for the necessary photographs to the Corps Squadron Commander, who will obtain them from his brigade if outside the squadron photographic area. Photography is the basis of good counter-battery work.

13. *Observation of Fire.*—To obtain the accuracy of fire which is necessary if counter-battery work is to be of any value, good observation is essential. The aerial observer enjoys direct and unobstructed vision from a most advantageous position, such as is obtained by no other method. Provided hostile batteries are accurately located, good neutralization fire can be obtained without aerial observation, but to attempt destructive fire without such observation is almost always a waste of ammunition. Since the number of airplanes that can work simultaneously on any front is limited, one of the chief duties of the counter-battery group commander is to draw up his daily program of pre-arranged shoots in such a way as to admit of the maximum amount of aerial observation of fire for destruction. Each machine is given certain batteries to work with and certain targets to engage. Either the pilot or the observer undertakes these shoots. If during the shoot he sees another battery active, he can engage it if he has one of the batteries allotted to him available, but may only in exceptional cases interrupt the shoot on which he is engaged. Meanwhile, whichever of the two is not doing the ranging watches for the new gun positions and active batteries, and reports the latter by wireless so that they can be neutralized and silenced at once, or be noted for destruction as soon as an opportunity offers.

Fire for destruction with airplane observation should, if possible, be followed by two ground observing stations, the observers being informed when the airplane gives O. K. This procedure may assist to secure accurate fire at some future date when no airplane is available.

14. *Necessity for Close Touch.*—The necessity for the closest personal touch between the Artillery and the Flying Corps cannot be too strongly urged. However systematic cooperation may be, difficulties are bound to occur from the very nature of the work. The simplest and best way of avoiding difficulties and of putting matters right when failures occur is by mutual discussion between the Battery Commander and the Aerial Observer.

Failures must always be investigated by the Squadron Commander, and by the Wireless Assistant Equipment Officer if a wireless failure, and a complete list of failures with results of investigations must be sent to Wing Headquarters daily in order that any action necessary to prevent their recurrence may be taken. Observers should utilize every opportunity of visiting the batteries allotted to them. On non-flying days Squadron and Balloon Company Commanders should arrange to send observers out to the batteries with which they work, in order to watch the procedure during a shoot so that they may get some idea of the difficulties and delay with which the Artillery has to compete.

A new observer should spend two or three days with a battery before he commences to range guns and should see it firing with airplane obser-

vation. Similarly, Artillery officers should, if possible, spend a few days with their corps squadron and balloon company. An Artillery liaison officer is attached to each Corps Wing Headquarters to assist the Wing Commander in ensuring successful cooperation.

Communication.

15. *General.*—Given good organization and well-trained personnel, effective co-operation between artillery and aircraft is largely dependent on rapid and reliable communication to and from the air and on the ground.

16. *Communication from the Airplane to the Artillery.*—Wireless is the principal means of communication from air to ground, and all airplanes doing artillery work will normally be provided with wireless transmitting sets. The following should be provided with ground receiving sets:

Headquarters of Corps Artillery.
Headquarters of Corp Artillery Groups.
Heavy batteries or detached sections of the same.
Divisional Artillery Headquarters.
Field Artillery Regimental or Group Headquarters.
Squadron Headquarters (two sets).
Balloon Companies

One of the Squadron Headquarters stations should be located at Squadron Headquarters for practice and tests; the other should be at Corps Artillery Headquarters, or at any central position in the corps area sufficiently far back to prevent jambing. This latter station should be joined to Squadron Headquarters by a direct telephone line, and acts as the link between the squadron commander and his machines working on the line. At this station are taken wireless reports, hostile aircraft reports, and, in case of sudden enemy bombardments or attacks, calls for reinforcing machines.

The artillery work of any particular machine may be taken if required, and an observer failing to get a reply to his signals can test his wireless over this station. Two operators are required for each ground set. Their sole duty is the reception of wireless messages; orderlies and other means must be provided by the artillery unit concerned for the further transmission of messages received. If more than one airplane using wireless is employed per one thousand yards of front serious jambing is liable to occur; adjacent machines must work on different wave lengths. These lengths are allotted for the whole front by Headquarters, Flying Corps.

If machines are not fitted with wireless a system of communication by lamp or Very's lights must be adopted, but both methods are slow and uncertain. When using lamps the observer must know the exact position of the battery with which he is working in order to be able to direct his lamp quickly and accurately. With Very's lights the number of different signals that can be made is strictly limited.

17. *Communication from the Artillery to the Airplane.*—Communication from the ground to the airplane is by means of ground signals, *i. e.*, strips of white cloth laid on the ground according to a pre-arranged code. The number of signals sent to the machine from the ground must be reduced to the minimum necessary. The best place for observation is over the target, whereas the airplane must fly back over the

battery to read ground signals. Time is thus wasted and the continuous observation of the target interrupted. It is important, however, that the airplane observer should, whenever possible, know with what battery he is working, so that he may watch for the flash of its guns. He will thus be able to distinguish the burst of its shell from those of other batteries firing on targets in the vicinity.

18. *Communication on the Ground.*—Communication on the ground is equally important, and direct telephonic communication is necessary between the corps artillery commander and the corps squadron and balloon company respectively, and also between the two latter and the counter-battery commander, if one is appointed. It is also essential that corps squadrons should be able to communicate easily and quickly by telephone with all the counter-battery group and battery commanders with whom they are working.

19. *Signals in Use.*—The following code will be used:

(1) AIRPLANE TO ARTILLERY—WIRELESS OR LAMPS.

Air	AR
Anti-aircraft guns	AA
Are you firing	RUF
Are you receiving my signals	B
Am returning to landing ground	CI
Are you ready to fire	KQ
Artillery	ART
Battery fire	BF
Cavalry	CAV
Change to	X
Column	COL
Continue firing in your own time	GO
Fire	G
Fire for effect (fleeting opportunity signal)	GF
All avilable batteries to open fire (sudden attack or very favorable target)	LL
General answer	T
Guns in position at	N
Guns firing in position at	NF
Guns not firing at	NT
Graze	GZ
High explosive	L
Infantry	FAN
Mechanical transport	MT
Mostly (as in mostly graze), or mean point of impact	M
Mostly left to avoid confusion with "wait"	QM
Percussion	P
Shoot unobserved or wash-out	W
Salvo	VO
Stand by	A
Stop firing or wait	MQ
Switch	SW
Tanks	TNK
Target (range)	OK
Time shrapnel	Z
Over	O

Short.....S
Right.....R
Left.....Q
More right.....RR
More left.....QQ
Just.....J
Far.....F

The call LL is used in cases of emergency, *i. e.*, a sudden attack or when a particularly favorable target presents itself. Any battery within range should open fire on receipt of this call. It should, therefore, be used only in exceptional circumstances since it will result in other work being temporarily suspended. The call must be changed periodically in case the enemy should make use of it to interfere with our fire.

The stand by signal "A" before nature of target, *i. e.*, ANF, signifies that observer is prepared to range a single battery on the target. The signal AA is sent immediately after NF.

(2) AIRPLANES TO ARTILLERY—VERY'S LIGHTS.

Line.	*Range.*	*Signal.*
No correction.	Over.	Red.
No correction	Short.	Green.
Right.	Over.	Red Red.
Right.	Short.	Red Green.
Left.	Over.	Green Red.
Left.	Short.	Green Green.
Correct.	Correct.	Red Green Red.
Stop firing.	.....	Red Red Red.

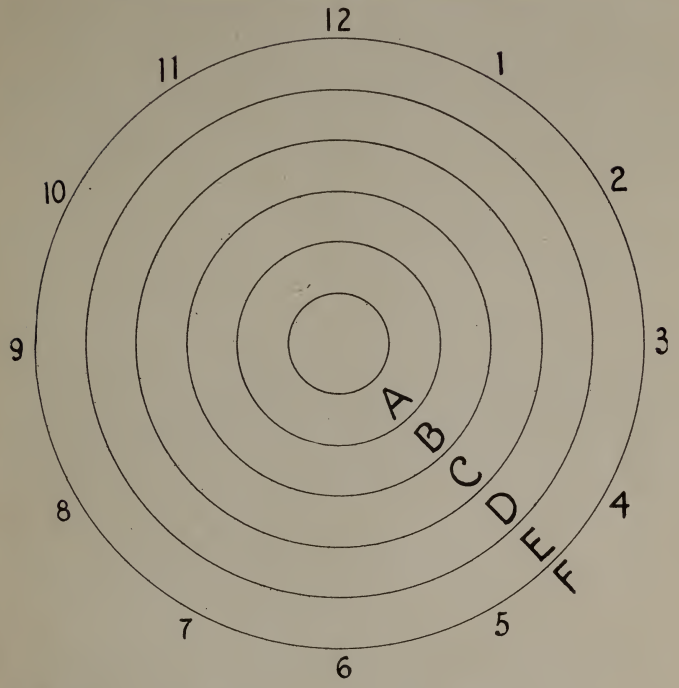
In the event of the supply of lights running short, a complete circle to the right may be substituted for a red light and a complete circle to the left for a green light.

Thus: Two circles right Red Red, *i. e.*, Right and Over.

If it is required to range for fuze, the observer fires the following signals:

For bursts on graze.....Green.
For bursts in air.....Red.

(3) AIRPLANE TO ARTILLERY—CLOCK CODE.



The target is regarded as the center of a clock, with 12 o'clock pointing true north and the remaining hours accordingly. Imaginary circles with the target as center at radial distances of 10, 25, 50, 100, 200, 300, 400, and 500 yards from the target are lettered Y, Z, A, B, C, D, E, F, respectively. The observer notes the fall of a round with reference to the imaginary circle and clock hours, and signals the result thus: Y 4, B 6.

When observing single rounds a shell will be reported as OK in the event of a direct hit on the target, *i. e.*, on a gun emplacement in the case of a battery. When firing salvos or single rounds of battery fire at a quick rate, the observer will report the mean point of impact of the round with reference to the actual point aimed at, *i. e.*, "MY2" (mean point of impact Y2). When, however, fire is distributed over the target (*i. e.*, a length of trench or a hostile battery under neutralizing fire) then the mean point of impact will be given with reference to the center of the target. Observation of rounds bursting on graze when time shrapnel is being fired will be preceded by the graze signal GZ, *i. e.*, a shell bursting on graze 50 yards from the target at 5 o'clock will be signalled at GZA 5. A celluloid disc with hour lines cut in its circles, according to the scale of the map in use, is of great assistance to the observer.

Corrections from Observations by the "Clock Code."

To make a diagram from which a correction may be read immediately on receiving observation according to the clock code: This diagram may be made to any scale, and for any range, or bearing.

(*a*) The original diagram was evolved as follows:

1. A sheet of paper was laid over the map used, and a pencil-dot made to mark the battery (s) with another to mark the target (t). A line was then drawn joining these two points, with another through (t) marking the North and South line (which was also to be the XII–VI line) (Fig. 1).

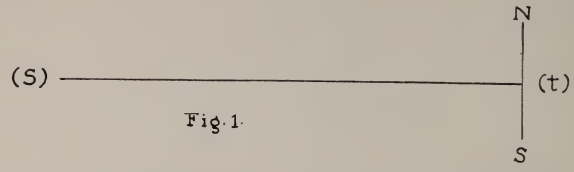


Fig. 1.

2. Radial lines were then drawn with center (s) on either side of the line of fire (s)–(t), at angles of 1, 2, 3, 4 and 5 degrees.

3. Circles were drawn with center (t) to the scale of the map, at A B C D E F 50, 100, 200, 300, 400, and 500 yards (Fig. 2).

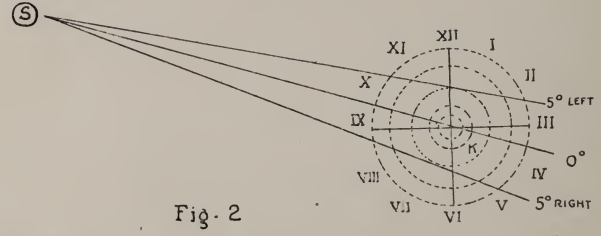


Fig. 2

This was simply the "clock-face" as laid down above.

4. X and K are two bursts sent down by the observer as "DXI" and "C4." Deflection is read off the radial lines, *i. e.*, "DII-6° more right" Range was measure by the scale "C4"-"4° more left") of the map.

(*b*) This original diagram had the disadvantage that a new drawing was required for every target, owing to varying ranges and bearings. This may be obviated as follows:

1. A constant scale may be employed, and marked off in hundreds of yards (Fig. 3).

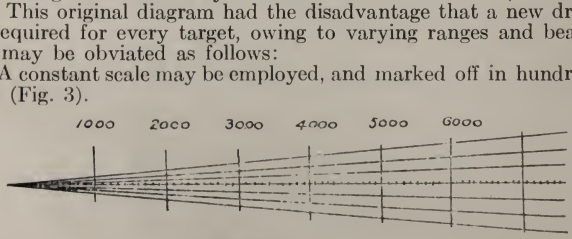


Fig 3

2. The "clock-face" may be made of celluloid with the XII-VI line heavily marked.

3. Both "clock-face" and radial diagram may be of *any* scale provided that they correspond.

4. The "clock-face" is laid on the deflection diagram with the center on the *map-range*, and the *twelve o'clock line making an angle with the line of fire corresponding to the true bearing of the target* (Fig. 4).

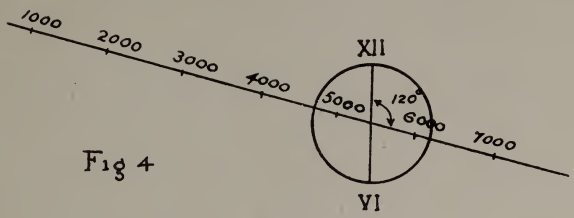


Fig 4

Range, 5400; true bearing, 120.

5. Obviously, if the target were *true North* the line of fire would be the VI-XII line, and the angle indicated would be 0° (bearing). Similarly *due South*, bearing 100, the line of fire would be the line XII-VI line.

Target bearing 270° (due west) the same angle is measured externally (Fig. 5).

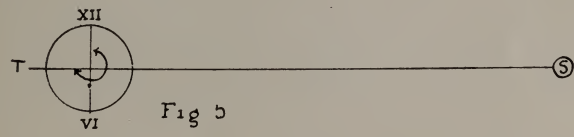


Fig 5

Corrections may be read straight off as before, with the additional advantage of reading off the range also.

(3) ARTILLERY TO AIRPLANE—GROUND SIGNALS (STRIPS OF WHITE CLOTH 12 FEET BY 1 FOOT).

Ready to engage target.....L
Ready to engage target (battery using one gun only).....L
When targets have been reported and numbered, the target to be engaged can be shown by Roman figures, *i. e.*, ready to engage target N IV.....LIV
Battery receiving signals, but guns not ready to fire.....△
(With a bar underneath for every ten minutes that will probably elapse before guns are ready.)
Yes.....K
Go home.....T
With figure added means go home for 1, 2, 3 hours.....T III
Observe for time shrapnel.....Z
Observe for fire effect.....V
Am not receiving your signals.....II
Signals weak.....H

Wireless not ready ..... W
Repeat ..... Y
Repeat last observation ..... Y
Repeat last two observations ..... Y
No ..... N
Message received ..... F
Change to another target (followed, if necessary, by the designation of the target) LX
Target not understood or not received ..... ▭

If it is necessary to distinguish between batteries close together, Roman figures placed under other signals can be used. Ground signals will be placed so as to be read from the target side of the battery.

Artillery commanders must see that the ground signals are complete, correct and suitably placed, and that there is no delay in putting them out. An open dark-colored piece of ground should be selected, away from other objects, such as trenches, chalk heaps, etc., likely to catch the observer's eye. A man must be detailed by the Artillery unit concerned to work the ground signals; the wireless operator is fully occupied.

(4) ARTILLERY TO AIRPLANE—MORSE SIGNALS WHEN USING LAMPS.

Calling up ..... Series of dots.
Change to (followed, if necessary, by designation of target) X
General answer ..... T
Go home CI
Battery receiving signals, but guns not ready to fire; or "yes" in answer to a question ..... K
Gun fired ..... Series of dashes.
No ..... N
Observe for high explosive ..... LYD
Observe for percussion ..... P
Observe for time shrapnel ..... Z
Observe for fire effect V
Observe for battery fire ..... BF
Ready to engage target (stand by) L
Repeat ..... Y
Am not receiving your signals II
Signals weak ..... H
Wireless not ready ..... W

Reporting of Targets.

A. WIRELESS OR LAMP.

20. When indicating the individual guns of a hostile battery, the right hand gun from the point of view of a man standing in the hostile battery, and facing the direction in which the battery fires, will be called No. 1 gun.

General.—Co-operation between aircraft and artillery may take place under three different sets of conditions: (1) when the position and arc of fire of our own battery and also the position of the target it is proposed to engage are known to both battery and airplane; (2) when the position and arc of fire of our own battery are known, but the position

of the target is unknown until discovered by the airplane; (3) when the position of our own battery is not known to the airplane, nor the position of the targets until discovered by the airplane.

Under the first set of conditions the shoot can be arranged beforehand and carried out as described in paragraph 21.

Under the second and third conditions a system is necessary by which the airplane can inform the artillery of the nature and location of targets discovered during a flight, and of the extent to which it is able to observe fire on them. During open warfare the third set of conditions may be expected to be normal, except perhaps in the case of the heavier types of tractor-drawn artillery. The entry of these into action will be deliberate, and it should be possible in most cases to keep the Flying Corps informed as to their positions and arcs of fire.

21. *Squadron Call System.*—This system is used in the case of pre-arranged shoots, or when the observer wishes to call up a particular battery after reporting the target by the Zone call system described below.

Separate prefix calls are allotted (*a*) to each squadron by Flying Corps Headquarters; (*b*) to each battery placed at the direct call of airplane observers, by squadron commanders; (*c*) to other batteries or Field Artillery Group Headquarters by squadron commanders, the call holding good for the particular shoot only.

These prefix calls are usually letters.

Suppose the squadron call to be P and the battery call F, the call used by the airplane to call up the battery is PF, and this call precedes every message sent by the airplane. In addition to squadron and battery calls, special calls (numbers) are allotted to each individual airplane pilot or observer by the squadron commander. These calls will be used in the case of pre-arranged shoots, or of impromptu shoots with a single battery, when (*a*) calling up a battery until the first observation has been sent down; (*b*) changing from one target to another; (*c*) sending CL.

They will be sent immediately after the squadron call, *i. e.*, P 3 F.

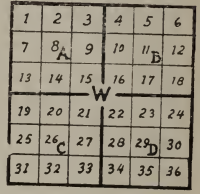
Should a battery wish to register a number of targets, call for each target should be arranged beforehand. They can conveniently consist of the battery call letter, followed by the number of the target according to the order in which they are to be engaged. Thus, if a battery whose call is L wishes to register four targets, the target calls will be L1, L2, L3, L4.

22. *Zone Call System.*—For other than pre-arranged shoots, the system used necessitates both battery and observer in possession of maps squared on the same system. A suitable division is into main lettered squares of 6,000 yards sides and subsidiary numbered squares of 1,000 yards sides. For the purpose of wireless zone calls the big lettered squares on the map are divided into four parts, as shown by the thick lines and letters in the diagram below. The whole area covered by the map is thus automatically divided into zones 3,000 yards by 3,000 yards, each having a two-letter call which consists of the map square letter followed by the zone letter, *i. e.*, W. B. is the call of the north-eastern zone of the square W. Owing to the area covered by each sheet of the map no doubt should arise as to the sheet referred to and the sheet number will not therefore be included in the call.

The 1,000 yards squares on these maps can be further subdivided into 500 yards squares lettered A, B, C, D, read horizontally from the top left hand square.

23. *Application of the System.*—The Flying Corps arrange for a suitable number of artillery machines to watch the zones on the immediate front of the Army, and allot squadrons to counter-battery areas corresponding with their corps front as far as possible. The limits of counter-battery areas should coincide, as far as possible, with the boundaries of zones.

These areas are subdivided into Detachment counter-battery areas consisting of probably two or three zones (3,000 by 3,000 yards each).



24. *Calls and Messages from the Air.*—(1) The airplane observer sends down information regarding any hostile troops or active batteries, other than those on which shoots have been pre-arranged, which he may see in the zone alloted to him, under the call of the particular zone in which the target is seen. Squadron calls are not used.

In order that the message may be generally understood, targets must invariably be sent down by the co-ordinates.

If the target is in the Detachment counter-battery area, the co-ordinates may be followed by a serial number (target call N1, etc.) which will hold good for the period of the current flight only.

Targets in other areas may be sent down, but in order to avoid confusion no serial number should be sent.

(2) Troops are considered in mass unless stated to be in column, and a column to be at rest unless the direction of movement is given. Co-ordinates of a mass or of a column at rest refer to the center, and of a moving column to the head.

Examples.—Zone W:

(*a*) WA NF W9c52=guns in action at W.9.c.5.2.

(*b*) WD COL 2,000 FAN W W 29a 24=2,000 infantry in column moving W. at W.29.a.2.4.

A call such as (*b*) may be preceded by LL (favorable target call).

(3) Should the observer wish to observe for a particular battery, whose call and position he knows, the target abbreviations will be preceded by the wait signal MQ. He is then free to call up and observe the particular battery by squadron and battery call.

Example.—W B MQNF W6d24=Guns in action at W.6.d.2.4. (observer is about to call up a particular battery).

(4) If the observer is ready to observe for a single battery on the target, but does not know the call or position of any particular battery he will send the "stand by" signal A immediately before the target abbreviation. A battery will then be detailed by the artillery commander concerned.

Example.—WB ANF W12c54 N1=Guns in action at W.12.c.54 (observer is prepared to observe for a single battery).

(5) The observer may recommend that the target should be engaged by either guns or howitzers by adding a number to the zone call as follows: W B 1=call for guns (heavy guns if available); W B 2=call for howitzers.

To summarize.—Zone WA:

(*a*) W A NF W2d45 N1=Call for fire from any battery (gun or howitzer on active battery at W.2.d.45). General corrections may be sent.

(*b*) W A MQNF W2d45=Signifies that observer intends to observe for a particular battery on active battery at W.2.d.45, and will call it up squadron and battery call. Stops fire called for by (*a*) above, to allow observer to observe for the particular battery.

(*c*) W A ANF W2d45 N1=Same as (*b*), but observer asks group to choose a battery to engage a target instead of choosing one himself.

(*d*) W A 2 ANFW2d45 N1=Same as (*c*), but observer suggests use of howitzers.

25. *Arrangements on the Ground.*—(*a*) Receipt of calls: Officers commanding groups, brigades or batteries to which wireless receiving sets are attached must keep the wireless operator informed as to which zone calls he is to take, *i. e.*, those of the zones into which they can fire. All such calls will be taken by the operator and reported to the officer commanding the battery or group with which he is working. The operator should not be asked to take the calls or other zones, or, while doing so, he may miss those which concern his unit.

Divisional and Corps Artillery Commanders can instruct their wireless operators to take messages from whatever portion of the line information is required.

(*b*) Answering Calls: The arrangements to be made for answering calls from the air must be decided by the Artillery Commander concerned. The following examples are merely intended to indicate the general procedure:

X group with wireless station attached consists of a number of 3 inch and 4.7 inch guns and 6 inch howitzers. The zones covered by the guns of the group are K D and L C.

(1) Messages Received: K D FAN 1000 K.23.b.33.

Officer commanding X group directs shrapnel fire to be opened on the target by two 3 inch batteries and one 4.7 inch battery. The airplane observer may send any observation he may be able to make under the target call, or under the co-ordinates if no target call has been allotted. If the above call was preceded by the favorable target call "LL", all available guns would be turned onto the target.

(2) Message Received: L C 1 NF L.32.a.78.

Officer commanding X group may turn both 4.7 inch batteries onto this target, one battery using shrapnel and the other H.E., or if 4.7 inch batteries are not available, may use any other type of gun. The airplane observer acts as in (1).

(3) Message Received: L C 2 ANF L.21.d.43 N1.

Officer commanding X group details one 6 inch howitzer battery, or if he considers it preferable a battery of 4.7 inch guns. The airplane observer ranges the battery under call N1, *i. e.*, L C N1G.L C N1 D 4, etc.

(4) Message Received: LC MQNF L.20.c.16.

This signifies that the observer intends to call up a particular battery and observe for it, as described in Par. 21. Suppose the squadron call to be P, the observer's call 2, and battery call L. The observer would next send down—

P 2 L NF L.13.c.16. N1.

The Group Commander can keep the whole control in his own hands as in the above examples, or he can detail the batteries to answer first calls for each type in each zone.

B.—VERY'S LIGHTS OR SMOKE SIGNALS.

26. *General Procedure.*—When Very's lights or smoke puffs are used as signals the position of a target can be shown by the airplane flying to a position vertically over the target, and there firing off a Very's light or smoke puff.

The range may be obtained from the following data: (1) The angle of sight of the airplane flying at a pre-arranged height. (2) The range of the airplane when it is vertically over the target at a pre-arranged height. (3) The range and angle of sight when the airplane is vertically over the target, but its altitude is unknown.

The methods given above for finding the range of a target may, if desired, be used in combination and the mean of the results taken. The airplane is followed by the director, and at the moment the signal is given the angle shown on the director is read off. This gives the line.

Ranging when Using Wireless.

27. *General.*—An observer must, when possible, find out exactly wha is required before going up. For instance, the fire which he is observing may be for effect, or merely to register certain definite points. Again, a battery commander may wish to correct the line and range of all the guns of his battery and so require observation of fire for each one, or may only want observation for the particular gun selected to carry out the ranging.

A. PREARRANGED SHOOTS.

28. *Details of System.*—The observer, having received his orders and left the ground, tests his wireless over the airdrome where the ground signal is put out to show that the signals are strong and clear. He then calls up the stations of the batteries with which he is to work, and asks if they are receiving his signals, "B." The station or stations answer by lamps or strips on the ground, sending K if the signals are being received. While climbing the observer sends his call at frequent intervals to enable the operator to tune to his wave-length.

The observer having got his height sends A (stand by) followed by the designation of the target to be engaged. The battery replies by F (message received). The battery then puts out T if the Battery cannot fire at all, a △ if any delay is anticipated, and L as soon as the guns are laid and ready to fire. If the battery cannot fire on the particular target sent down, but is ready to fire on other targets, LX is put out. It is important that one or other of these signals should be put out at once. If this is not done the observer assumes the presence of hostile aircraft, or that his wireless is not working properly, and much time may be wasted.

All signals from the ground are acknowledged by the observer by the general answer T.

The observer flies to a convenient position for observing the fall of shell and gives the signal G (fire). The battery should then fire immediately; if not ready within ten seconds it should wait for the signal G to be re-

peated. In order to avoid the strain of continually staring at the target area, and to minimize the possibility of confusion with other bursts, the observer will watch for the flash of a gun firing and then look towards the target to observe the fall of the shell. He should know the approximate time of flight.

After ranging has commenced, if the observer is not quite sure whether a gun has fired or not, he will signal W, meaning shot unobserved, before again signalling G. If the battery has fired, the receipt of the signal "Shot unobserved" will give it time to lay before receiving the signal G.

The observer sends the observation giving the position of the shell with reference to the target by means of the Clock Code. This procedure is continued until the ranging is completed.

29. *Nature of Projectiles.*—As a rule single rounds are sufficient for observation, but it may sometimes be necessary to fire salvos of two or more guns. If the gun can fire shrapnel the observer may signal for time shrapnel to be used during ranging when observation is difficult (or a few rounds of time shrapnel may be fired on the initiative of the battery commander after a series of unobserved rounds). In such cases when the shell has been brought near the target the observer may signal "Change to Percussion" or "Change to H. E." so as to get more accurate results. Observation will then be easier as the observer will know where to expect the shell to fall.

It may also assist an observer to distinguish the shell of his particular Battery from that of others firing into the same area if he calles for salvos to be fired or for time shrapnel.

There is every chance for the first shot being missed if it does not fall where the observer expects to see it. It is therefore desirable that the Battery Commander should endeavor to place the first shell where its bursts will not be concealed by woods, etc.

30. *Corrections of Line and Range.*—If the guns are well calibrated the line and range of one gun may be found and the necessary corrections supplied to the other guns. If, however, the Battery Commander wishes to correct the line and range of all the guns of his battery he will fire them in turn and receive observations for each.

The observer will send G when ready to observe the first gun. The Battery Commander will then fire each gun in succession, receiving observations of each round. The correction due to an observation is applied only to the gun concerned so that it is only necessary to wait for the signal G before firing the next gun. The observer should give G immediately after the observation of the preceding round.

The observer will continue as above until the range and line for each gun is satisfactory, or until the Battery Commander signals V (observe for fire effect) and commences battery fire.

31. *Switches.*—The observer, while a shoot is in progress, may switch a battery by the signal X onto a fresh objective when he sees a fleeting or important new target, or when further shooting at the old target is useless owing to difficulties in observation, etc., but a shoot once begun must be completed if possible. The observer should, therefore, normally call up another Battery if he is himself prepared to observe fire on the new target.

If a hostile battery being ranged on is silenced, the observer will complete ranging and then signal NT (guns no longer firing).

B. Impromptu Shoots.

32. *Details of System.*—If the observer wishes to observe for a particular Battery, he sends down the target as described in paragraph 24 (3) and then calls up the particular Battery as described in paragraph 21. If the observer is prepared to observe for a single Battery he sends the signals described in paragraph 24 (4), but in this case must allow sufficient time for the Battery to be detailed and the guns laid before sending G.

RANGING WHEN USING LAMP.

33. *Outline of System.*—The observer flies over the ground station and calls it up with the lamp. The remainder of the procedure is similar to that followed when using wireless, except that the Battery repeats each signal sent by the observer until the general answer is received from the airplane in acknowledgment. This eliminates the likelihood of any mistakes. When signalling, the observer must ensure that his lamp is accurately aligned on the battery in order that his signals may be clearly read. In a moving battle, airplanes using signalling lamps may show that they wish to signal information by making a complete circle over the unit to which they wish to signal.

RANGING WHEN USING VERY'S LIGHTS AND CIRCLING SIGNALS.

34. *Outline of System.*—Success when using these forms of signalling is largely dependent upon the Battery Commander knowing the most suitable time to fire, in order to enable the observer to see the fall of the shell. All signals to change the target or the nature of fire must be sent from the ground.

Where it is necessary to give the Battery Commander more information than can be conveyed by signals, the observer must drop a message bag. If it has not been possible to make preliminary arrangements, the observer will drop a message stating the course he proposes to fly and when it is most convenient for the Battery to fire. Signals should not be made from the air when the airplane is between the sun and the Battery.

Two men should be detailed from the Battery to watch the observing airplane, one with field glasses looking for the signals, and the other with his naked eye keeping a continuous watch on it so as to make certain that no mistake is made as to the actual machine, since, when there are serveral aircraft out, confusion between them is likely to arise.

METHODS OF FIRE.

35. *General.*—Artillery may fire either for registration purposes or for effect, and fire for effect includes neutralization fire and destructive fire. The procedure after ranging is complete depends on the nature of fire required.

36. *Registration.*—When registration of targets is being carried out, each round will be observed throughout the shoot, and the signal "change to a fresh target" will be made by the Battery, unless arrangements have been made before going up that the signal to change is to be given by the observer. In the latter case, it should be remembered that a gun will generally be loaded, ready to fire at the old target when the signal to change is given.

37. *Neutralization.*—In the case of neutralization fire, speed is the essential, and rapid fire will be opened as soon as the approximate range and line have been obtained. The decision as to when to open rapid fire will rest with the Battery Commander and not with the observer.

Preparation for neutralization during an attack may be made by registering particular batteries on known hostile batteries immediately prior to an assault. Such batteries are then in a position to neutralize, without air observation, the batteries on which they are registered, should these batteries open fire during the attack. If the target is not being hit, the observer should, whenever the situation admits of his watching the effect of the fire, send down the mean point of impact of a number of rounds with reference to the center of a target using the signal M, followed by the location in the Clock Code. If more than one battery is firing and the fire is producing some effect on the target, corrections should not be sent as they may result in putting batteries which have the correct range off the target. During a battle or any period of activity, fire will very often be from the map, without observation.

In the case of moving targets, the observer must signal his observation with regard to the position of the target at the moment the shell bursts. It is for the Artillery Commander to predict the position of the target when the next round bursts and to make allowances accordingly.

38. *Fire for Destruction.*—Fire must be carefully controlled and observed, not only during ranging, but also while firing for effect, if destruction is to be definitely achieved. Howitzers, but more particularly guns, have a tendency to lose exact range or line to a target from a variety of causes, even though ranging may have been satisfactorily accomplished. Fire must be directed at a particular point, such as a hostile gun emplacement, or trench junction.

When the observer, seeing that adequate effect has been obtained on one gun, wishes to switch on to the next, he will use the signal SW, followed by the Clock Code. This will indicate the distance and direction that the battery should switch in order to hit the next gun. The same method may also be used when bombarding successive points on a hostile trench line.

When ranging has been accomplished, *i. e.*, when the mean point of impact on the emplacement or other target has been established, a series of rounds (the number depending on the caliber and nature of the weapon employed) should be fired without correction. Observations should then be sent down for the mean point of impact of these rounds, and the procedure repeated, and so on.

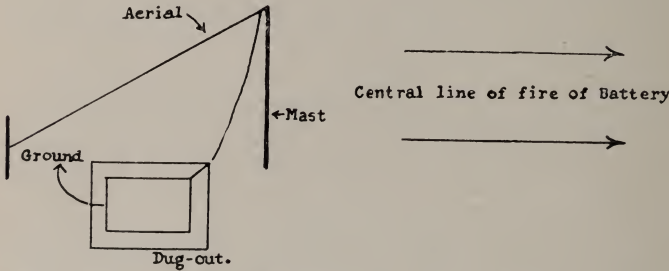
When the Battery Commander considers that his guns are ranged sufficiently accurately, he orders battery fire at a small interval and puts out a V on the ground in place of an L. The observer may not see the V, but should always watch the battery for a few seconds after a gun has fired in response to his G. He will then be able to see when battery fire is started. Corrections are given for a group of rounds as described above.

Airplane observation should invariably be provided, if the tactical situation admits, in the case of fire for destruction when accurate observation from the ground is impossible.

Wireless.

39. *Prevention of Jambings.*—The number of airplanes using wireless which can work on any front without jambing each other's signals is limited, and depends largely on the skill of the observers and wireless operators, and the amount of supervision and attention to detail on the part of Squadron Commanders and wireless officers. Generally speaking, one machine to every 1,000 yards is the maximum, and this is still further limited if some machines are working far out and others close in. Even at the above interval, adjacent machines must use different wave lengths and should if possible, employ signals of different tones. Wave lengths and tones on the whole front are allotted by Headquarters Flying Corps.

40. *Care of Instruments.*—Wireless instruments are delicate and easily get out of order. Wireless officers are responsible that all wireless personnel are thoroughly trained in the care and adjustments of their instruments. Artillery Commanders to whose units wireless stations are attached must ensure that adequate care is taken of the instruments, especially when on the move



41. *Erection of Station.*—Wireless masts must be erected on highest ground in the vicinity of the unit with which they are working and must be arranged as shown in the diagram below, with the mast towards the target.

The ground lead should be short and straight and carried to ground as directly as possible. Care must be taken that the ground lead is not brought round the instrument or run in close proximity to the aerial lead. The ground mat should be parallel to and immediately under the aerial, as close to the tuner as possible, and buried. If the operator is provided with a deep dugout, it is better to arrange the ground mat in the dugout rather than to bring it up to the surface by a long lead. Aerial leads must be carefully insulated and must not touch or be led through ground. Care must be taken that they do not come in contact with the iron supports or roof of dug-outs.

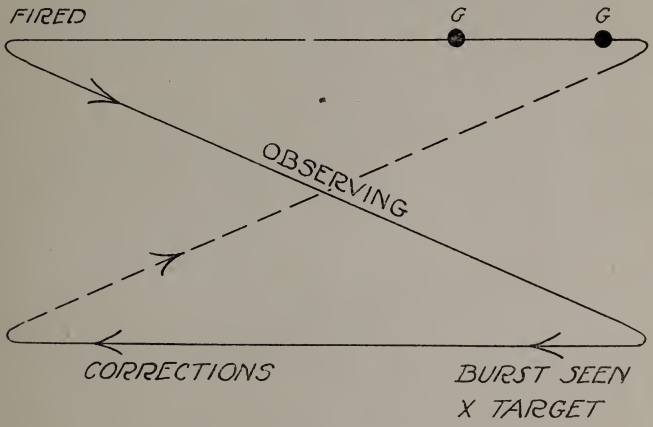
Wireless officers are primarily responsible that stations are properly erected, but Artillery Commanders must make themselves acquainted with the correct method and assist the wireless officer in this matter.

Artillery Commanders are also responsible that suitable cover is provided for the operators. It should be as sound proof as possible, and not too near the guns. The operator can be in the same dug-out

as the Battery Commander provided it is on high ground and not too close to the battery. Otherwise he must be provided with a separate dug-out and connected by telephone with the Battery Commander.

42. *Position when Sending.*—Wireless machines should work within 3,000 yards of their targets and should only come closer to the battery for which they are observing when it is apparent that the latter are not receiving their signals. The likelihood of jambing is increased by coming in close to the receiving station and time is wasted if machines do so unnecessarily.

The strength of the signals depend largely upon the direction in which the machine is flying with the respect to the ground aerial. The signals are strongest when the airplane is flying towards the battery in such a way that the airplane aerial is in line with or parallel to the ground aerial. The weakest signals are the consequence of sending when flying away from the battery. Flying across the line of the ground aerial gives medium signals. Signals must never be sent when a machine is turning. The following diagram suggests a good method of flying when ranging on a target so as to get the strongest signals:



Squadron Commanders must ensure that all pilots and observers realize the importance of sending from the right position. If sufficient attention is paid to detail and signals are sent correctly it is quite unnecessary for the observers to return close to their station before sending the signals. Messages must be kept as short as possible. The code

signals only must be used and must not be repeated more than twice at one time.

To save waste of time, if an observer finds that a battery is not getting his signals, he should return at once to his squadron, sending a message if he can for another machine to relieve him. On his return he should immediately investigate the cause of the failure. By calling up his squadron central or headquarters station before landing he can ascertain whether the failure is due to the transmitter or to the receiver.

43. *Receipt of Messages:* Each wireless station has two wireless operators. Commanders of units to which stations are attached are responsible that one operator is always on duty whenever there is any possibility of a machine working with his station. The operator must be informed by the unit with which he is working as to what calls he is to take and must be notified or any changes. He must report at once any messages received. Weather reports may be taken by operators attached to Artillery units, but press messages are on no account to be taken. Whenever possible all wireless messages taken during the day should be collected and examined by the Squadron Wireless Officer. The messages taken at batteries should be compared with those received at the squadron central station. The collection of this data will enable a check to be kept upon: (1) The sending of pilots and observers; (2) the efficiency of operators; (3) the amount of signalling sent from the air.

44. *Investigation of Failures:* Thorough investigation of every failure which occurs must be made by the Squadron, and if necessary by the Wing, Wireless Officer. The former (assisted by the wireless non-commissioned officer) should visit the batteries with which their squadron is working every day or two. The objects of these visits are: (1) To see that stations are correctly put up in the most suitable place; (2) to test the efficiency of operators; (3) to note any deficiency in the transmitting sets or any faults in the sending of observers; (4) to see that the operators tune in properly; (5) to ensure that observers give the operator a chance to tune in properly.

To carry out tests (2) to (5) the wireless officer should listen in himself. Wireless officers during these visits should make a point of seeing Battery Commanders and ascertaining whether they have any suggestions or complaints concerning the wireless work or the operators attached to their batteries.

45. *Weather Reports:* Weather reports as below should always be sent down to the squadron headquarters station, especially in unsettled weather.

When sending down weather reports by wireless, the following codes will be used:

Wind = W; Clouds = C; Height will be given in hundreds of feet, *i. e.*, W208W65 = Wind at 2,000 feet S. W. 65 m.p.h.; C25 = Clouds at 2,500 feet. Messages will always be sent in the above order, *i. e.*, W45NW50-C60 will be the method of sending, wind, at 4,500 feet N. W., 50 M.P.H., clouds 6,000 feet. OK phot. = All right for photography. OK art. = All right for Artillery observation.

The object of these weather reports is as follows:—(1) To let Flight Commanders know whether the weather is fit to send up machines for any particular duty; (2) to give the heavy howitzers direction and strength of the wind at various heights. Heavy howitzers get similar information from balloons.

Any changes in the weather while a machine is up should be sent down. Wireless operators attached to anti-aircraft guns should be instructed to take in these weather reports.

Reports.

46. *Report to Battery:*—Whenever possible the Battery Commander should receive a report from the observer on the shooting done. These reports will be made out as soon as the observer lands, wh le what has happened during a flight is fresh in his mind, and should contain the following information: (*a*) Fall of the rounds as observed. This is a check on any mistake in signalling observations; (*b*) an explanation of any difficulties the observer may have had to contend with; (*c*) a rough sketch of the sub-square, showing the position of the battery with the fall of the rounds marked on it; (*d*) If any direct hits were obtained on hostile guns.

These reports will be sent to batteries through their brigade headquarters. If possible the observer should go and see the Battery Commander as soon as a shoot is over, especially in case of failure. If he cannot do so, he should himself speak to the Battery Commander on the telephone.

47. *Squadron Records:* The first duties of pilots and observers on returning from Artillery work is to enter the result of their flight and all information obtained on a form provided for that purpose. Extracts from this form will be entered by the Squadron Recording Officer in the squadron record book and in a target book kept for the purpose. Each hostile battery is given one or more pages and all information concerning the battery is entered under various headings. Batteries are classed "A," "B" or "C" according to the accuracy with which their positions are located.

Those classed "A" or "B" will be given a number by the Army for convenience for reference and used as a target call in the case of prearranged shoots, and will be marked on a photograph. A record of the number of the photograph or photographs on which each battery will be found will be made in the target book.

48. *Reports to Corps Artillery:* When the tactical situation permits, daily reports will be sent by the squadron to General Officer commanding Artillery of the Corps, Brigadier General commanding Corps Heavy Artillery, and Corps Wing Headquarters. These reports show under the heading "active hostile batteries" all batteries seen active during the day, including batteries already known and numbered and those newly found or verified. Batteries will be classed "A," "B" or "C" as explained above. Under the heading "hostile battery positions reconnoitered" is given any information obtained concerning emplacements from which flashes have not been seen.

49. *Reports from Other Sources:* Artillery observation reports, Balloon and Field Survey Companies and Sound Ranging Sections furnish Corps Artillery and Corps Heavy Artillery headquarters with a similar list of active batteries located by them during the day. These batteries, if their positions are not already accurately located, should be reconnoitered and verified by the squadron concerned at the first opportunity.

50. *Weekly Lists:* Each squadron will send to Wing headquarters a weekly list of all hostile batteries located in the Corps area. All known batteries will be included in this list, which will show the time and date

on which each battery was last seen active. In the case of a battery classed "A" the coordinates of each gun should be given, and in the case of a battery classed "B" the coordinates of each end of the position.

The following should be noted: (1) Whether the hostile batteries have been heavily shelled by us; (2) whether it is thought that the hostile battery is still active; (3) whether it is thought that the hostile battery has moved, stating probable new position if possible.

Any information which may help Artillery Commanders to decide how best to engage a hostile battery should be added. Combined lists showing the active hostile batteries located up to date should be compiled and circulated weekly by the Field Survey Company. The officers of the Field Survey Company charged with making up the list should be in very close touch with squadrons, Flying Corps, and should take every opportunity of questioning pilots and observers.

Cooperation between Artillery and Balloons.

51. *General.*—Balloon companies are allotted to corps and provide further means of aerial observation in addition to the corps squadron. The cooperation between the Corps Artillery, the Squadron and the Balloon Company must be very close, and the allocation of work between the Squadron and the Balloon Company must be carefully thought out, so that each is allotted the task most suitable to it. Whenever possible, the officer commanding the Corps Squadrons and the Corps Balloons should meet the General Officer Commanding Artillery of the Corps the previous evening to arrange the work for the succeeding day.

52. *Employment of Balloons.*—Balloons, owing to their vulnerability to artillery fire, are forced to observe at long range. Compared with airplanes therefore, they obtain less direct observation, and their view may be hampered by dead ground, especially at long ranges. On the other hand, they enjoy better facilities for keeping a particular area of ground under continuous observation, the observer can use glasses of considerable power, and the means of communication by direct telephone to the Artillery are superior.

The work most suitable to balloons is consequently (*a*) spotting flashes of hostile guns; (*b*) reporting on the direction, intensity and results of hostile bombardments; (*c*) observation of fire at close and medium ranges; (*d*) observation of the enemy's defenses, location of machine guns, etc.; (*e*) observation of movements on roads and railways.

(*b*) Can be carried out, to a certain extent, by night as well as by day.

When conditions are favorable, observation of fire can be carried out by balloons at long ranges in open country, but experienced observers are necessary.

53. *Spotting Flashes.*—Owing to the facility with which an area can be kept under observation, the corps balloons could, during a battle, be able to keep the Artillery Commander constantly informed as to the activities of the enemy's batteries. The whole area allotted to each balloon must be watched, working from one flank to the other, and the facts of any hostile battery opening or ceasing fire must be reported at once to the Artillery Commander. Hostile active batteries sent down by airplane under the zone call and taken in by the balloon wireless station must be reported at once to the observer in the balloon. If there are two observers in a balloon, one can be employed to report on the enemy's artillery as above, while the second observes for our own batteries.

54. *Hostile Bombardments.*—Balloons, owing to their position, are suitably placed to observe hostile bombardment and barrage fire, and report on their intensity and the area bombarded. They can sometimes, in addition, observe the connection between the flashes of the enemy's guns and the fall of their shell. Such information is of value to the Artillery during trench warfare, since it enables the arcs of fire of the enemy's batteries to be established approximately. This in its turn enables counter-battery fire to be directed onto the most likely hostile batteries when any particular area is bombarded by the enemy subsequently, or when neutralization is required in connection with an operation in a particular area.

55. *Observation of Fire.*—Balloons may be used to observe fire on (*a*) trenches (except the front system where close to our own line); (*b*) strong points, villages, etc.; (*c*) batteries.

Observation of fire on trenches is usually for registration purposes previous to a bombardment. As it will not be possible to correct the fire during the bombardment the greatest accuracy is essential. In ground which has been much cut up the enemy trenches are usually very difficult to locate from a distance except when seen in enfilade, and this difficulty must be borne in mind when allotting targets to balloons. Observation from balloons is very dependent on the weather; ground mists, haze, and the position of the sun affect visibility to a very large extent. It is preferable, therefore, when prearranging shoots, to give the balloon observer a list of the targets which the artillery wishes to engage, and to leave it to him to decide, according to conditions after ascent, which targets can be engaged with a prospect of success and the order in which to engage them.

In addition to pre-arranged shoots on known targets, the procedure for engaging batteries seen active and other fleeting targets must be decided by Corps Artillery Commanders. Certain batteries can be placed at the direct call of the balloon when the latter observes a target, or a battery can be detailed by the Artillery Commander concerned on receipt of a report by telephone from the balloon. The former system tends to greater speed in the case of fleeting targets and to closer touch between batteries and observers. Such batteries should have a direct telephone line to the balloon, if possible.

56. *Ranging.*—Before a target is engaged the observer will send the following information to the battery: (*a*) The position and height of the balloon; (*b*) the direction and strength of the wind; (*c*) the position and nature of the target, if the shoot has not been pre-arranged.

The battery will inform the observer of the nature of projectile and fuze to be used and the approximate time of flight.

The observer will inform the battery when he is ready to observe.

Before firing each round "stand by" will be sent to the balloon.

The observer will then give "Ready." As soon as "Ready" is received by the battery, but not before, the gun will be fired at once. As the gun is fired "No. — fired" will be sent to the balloon.

When ranging, the Battery Commander must aim at obtaining a bracket on the line BALLOON—TARGET. The closer the line BALLOON—TARGET approximates to the line BATTERY—TARGET, the easier will be the ranging as the error of the gun is much less for line than for range. The observer will observe on the line BALLOON—TARGET, giving observations as follows: (*a*) Right or left.—The amount in degrees and minutes should be sent; (*b*) line and short or line and over; (*c*) unobserved.

If more than 300 yards short or over, the observation should be "far short" or "far over."

These observations may be qualified somewhat as follows:

Smoke rising behind house 1 degree right.

The observation short or over will not be given until the burst is on the line BALLOON—TARGET, unless the observer is perfectly confident that the round is short or over owing to its having fallen at some point easily recognizable on the map. With time-shrapnel a burst in the air above the line of sight BALLOON—TARGET is given as "Air Over," and a burst in air below the line of sight BALLOON—TARGET is given "Air Short." This enables the Battery Commander to find both his range and fuze.

The Battery Commander, and not the observer, is the judge of when the range and fuze have been found with sufficient accuracy to warrant fire for effect, or a change to another target if registration is in progress. It may sometimes be possible to arrange for cross-observation on a target from two balloons. Careful arrangement of communications is necessary to ensure that the observations from each balloon refer always to the same round, and the balloons should be in direct communication with one another. Each balloon sends down observations with regard to line only, giving the angular distance right or left of the line BALLOON—TARGET. The position of the rounds is plotted at the Battery.

57. *Communications.*—In order to get full values from balloon observation it is essential that a good system of ground communication is established. Each balloon must have communication by telephone with Artillery group headquarters, and through them with all batteries for which it observes. When possible, however, it is desirable that balloons should have their own system of communication direct with batteries in addition, in order to avoid frequent interruption during a shoot. This communication can be suitably arranged by establishing a forward balloon exchange in the area of the battery positions, with a double line back to the balloon exchange and single lines to the batteries with which the balloon works. Direct communication with the sound ranging section, if such exists, is of considerable value. Each balloon should have a telephone exchange on the ground where an officer must always be on duty when the balloon is up. He will be responsible that the necessary telephone communication is established in good time in the case of pre-arranged shoots, that all targets sent down by the observer are passed on at once to the group headquarters or battery concerned together with all necessary information, and also that instructions received from the Artillery are passed on to the observer.

58. *Records.*—The following, with which all officers must be conversant, will be kept in the exchange: (*a*) Diagram of the telephone communications of the balloon; (*b*) a map showing the positions of all batteries for which the balloon may have to observe, together with their arcs of fire; (*c*) a map showing the enemy defenses and the position of all accurately located hostile batteries, with their arcs of fire if known. Panoramic and airplane photographs of the latter also will be kept in the exchange. Section record books and target books will be kept as in the case of airplane squadrons, and similar reports will be rendered.

Duties of Pilots and Observers and of Recording Officers.

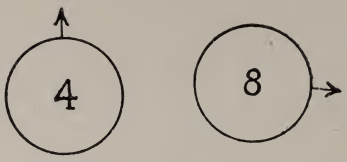
59. *Artillery Patrol Work.*—Guns in movement are usually easy to find, as little opportunity for concealing them exists when brought into action suddenly. Where guns are difficult to find the teams near at hand may sometimes be visible. On the other hand, the guns of a defensive line are difficult to locate. One of the most difficult tasks required of air observers is that of spotting hostile batteries firing on a bright day, locating them with absolute accuracy, ascertaining whether they are guns or howitzers, whether they are dummy or real, and discovering where the shells are falling. A careful study of the vertical and oblique photographs available is of great assistance. Emplacements are hidden away under trees and in orchards and gardens, and the teams are hidden well in the rear. Alternative emplacements are almost nvariably arranged and it is necessary to fly directly above them to tell whether they are occupied or not. Batteries seldom show signs of life when an airplane is overhead, except during a battle. Overhead cover can generally be noted by the observer if he knows the position of the battery beforehand, but the only way he can tell with certainty whether the emplacements are occupied is by seeing the guns actually firing or men going in or out.

Flashes are valuable guides, but care must be taken to distinguish between real and dummy flashes. The best way is to observe whether the fall of shell in our lines follows shortly on the flashes seen. The greatest care must be taken to locate flashes accurately, checking the location by further observation.

Field guns have a yellowish white flash which gives a decided kick forward. Small howitzers have rather a larger and yellower flash than the field gun, followed by a little puff of smoke. Large howitzers have a larger and redder flash than the smaller ones, and there is quite a big puff of yellow smoke succeeding the flash, which appears some two feet above it. Batteries sometimes use a flash reducer. The effect on the flash is as follows: The flash is red and appears a little in front of the muzzle of the gun, followed by a thin puff of smoke. This is very apt to be taken for a dummy flash. Big flashes should be mistrusted, especially if followed by smoke. Dummy flashes look about the same in color as gun flashes, but do not have the kick forward which distinguishes the latter.

When guns are seen in the open the observer must know whether there are any signs of personnel or wheel tracks in the vicinity; otherwise they may be dummies. Wheel tracks show up well on stubble, plough and snow, but do not show up well in wet weather. Tracks of men going to and from batteries show up well on grass, cultivation and snow, and are a good indication. Dummy gun pits are often made behind the guns; any cover, such as hedges in front of pits seen in the open, should therefore be carefully searched. Particular attention to be paid to cover close to roads. Before making a gun reconnaissance of an unfamiliar area, observers must study the map carefully for woods and depressions behind or in which howitzers are likely to be placed. Observers must know all the calls and positions of all located batteries, and must be given all available information regarding them. It will be of assistance if Artillery Staffs can indicate the localities where hostile batteries, which are unlocated, are suspected. The observer must search these areas carefully from overhead, and also watch for flashes from them when flying low behind our own lines. The latter method is often successful when the former fails.

Gun pits will be marked on a special squared artillery map by a circle showing the number of pits in it and giving the direction in which they face, thus:



A note will be made whenever possible as to whether gun pits previously reported are occupied or not. Unless an observer is quite sure that gun pits are occupied, he will report them as "Apparently occupied." It is a good plan to turn suddenly after passing over a suspected area, as guns often cease firing when an airplane approaches. Shelling by either side will be noted and its locality and intensity accurately reported.

Observers on Artillery Patrol should make all efforts to secure information regarding new trenches and works of every description, roads or railways and movements on them, collections of transports and material, billets, etc. The information so collected is reported to the intelligence branch of the corps staff, and, if the work is well done, it should reduce the amount of corps reconnaissance required.

60. *Work on Returning from Artillery Patrol.*—Immediately on returning from Artillery Patrol the observer must write a summary of the information obtained on a form provided for the purpose.

61. *Observation of Fire.*—Accurate observation of fire can only be carried out from a position as nearly as possible directly over the target. Observers must pay particular attention to the following points:

A. Wireless.

(1) No code signals other than those authorized must be used.

(2) Long messages which may jamb other machines must be avoided.

(3) Each signal should be sent twice clearly and crisply, particular attention being paid to correct formation of letters. After an interval of 10 seconds signals should be sent twice again, and no more.

Slow drawling signals are very hard to read through other and crisper signals. They are more easily jambed and at the same time cause jambing.

(4) The personal call of the pilot or observer must only be used when calling up the battery until the first round is fired, when calling up for each fresh target, and when sending C. I.

B. Gunnery.

(1) Observers must make themselves acquainted with the characteristics of the various guns and howitzers in use, *i. e.*, nature of bursts, time of flight at various ranges, projectiles used.

(2) Observers must study the arcs of fire of the batteries with which they work, and must avoid asking batteries to fire outside of their arc or beyond their range. Corps Artillery Headquarters should furnish the Corps Squadron with maps showing the arcs of fire of the batteries detailed to work direct with airplanes.

(3) If the observer has to break off a shoot, he must send CI, and explain fully after landing. The battery may be able to continue the shoot with balloon observation.

62. *Accuracy.*—The basis of successful cooperation between Aircraft and Artillery is mutual confidence. It is therefore the duty of every pilot and observer to be scrupulously careful as regards the accuracy of his work and the reliability of his reports. A well defined line must be drawn between what is certain and what is only surmised; and when ranging, above all, corrections must never be given unless the burst is seen and accurately located. Accuracy must not be sacrificed to speed, and if mistakes are made they must be admitted at once.

Pilots and observers must take every opportunity of visiting the batteries with which they work. It is only by watching batteries shooting with airplane observation that the observer can realize the difficulties and delays with which the Artillery has to compete. Moreover a report on the day's work, made verbally, and followed by discussion of any points that require elucidation, will do much to promote mutual confidence.

63. *Coordination of Artillery Work.*—The chief work of the Squadron Recording Officer is the coordination of the Artillery work. The following are some of his duties:

(1) To compile the program of pre-arranged shoots, and ensure that it is made known to all concerned.

(2) To notify other Squadrons when shoots are being carried out in their counter-battery area.

(3) To watch the number of machines using wireless on the squadron front, and to see that it is not excessive at any one time.

(4) To warn batteries when an airplane is going up to work with them, and to inform them at once of any postponement of pre-arranged work, whatever the cause.

(5) To keep observers informed of any change in the battery allotted to work direct with airplanes.

(6) To keep observers fully supplied with the latest information concerning the enemy's positions, especially his Artillery.

(7) To give observers, before they leave the ground, the latest information as to the enemy's batteries reported active, and the position of our own troops.

(8) To telephone all information received from the air to Corps and Artillery Headquarters.

(9) To interrogate observers on landing.

FIGHTING IN THE AIR.

General.

1. *The Necessity of Fighting.*—The uses of airplanes in war are many, but the efficient performance of their missions in every case depends on their ability to gain and maintain a position from which they can see the enemy's dispositions and movements. Cavalry on the ground have to fight and defeat the enemy's cavalry before they can gain information, and in the same way aerial fighting is usually necessary to enable airplanes to perform their other duties.

Artillery cooperation, photography, and similar work can only be successful if the enemy are prevented as far as possible from interfering

with the machines engaged on these duties, and such work by hostile machines can only be prevented by interference on our part.

The moral effect of a successful cavalry action is very great; equally so is that of successful fighting in the air. This is due to the fact that in many cases the combat is actually seen from the ground, while the results of successful fighting, even when not visible, are apparent to all. The moral effect produced by an airplane is also out of all proportion to the material damage which it can inflict, which in itself is considerable, and the mere presence of a hostile machine above them inspires those on the ground with exaggerated forebodings of what it is capable of doing. On the other hand the moral effect on our own troops of aerial ascendancy is most marked, and the sight of numbers of our machines continually at work over the enemy has as good an effect as the presence of hostile machines above us has had.

2. *Similarity to Fighting on Land and Sea.*—To seek out and destroy the enemy's forces must be the guiding principle of our tactics in the air, just as it is on land and at sea. The battle ground must be of our own choosing and not of the enemy's, and victory in the fight, to be complete, must bring other important results in its train. These results can only be achieved by gaining and keeping the ascendancy in the air. The more the complete ascendancy, the more far reaching will be the results.

The struggle for superiority takes the form, as in other fighting, of a series of combats, and it is by the moral and material effect of success in such combats that ascendancy over the enemy is gained.

3. *Necessity of Offensive Action.*—Offensive tactics are essential in aerial fighting for the following reasons:

(1) To gain ascendancy alluded to above.

(2) Because the field of action of airplanes is over and in rear of the hostile forces, and we must, therefore, attack in order to enable our machines to accomplish their missions, and prevent those of the enemy from accomplishing theirs.

(3) Because the airplane is eseentially a weapon of attack and not of defence. Fighting on land and sea takes place in two dimensions, but in the air we have to reckon with all three. Manoeuvering room, is therefore, unlimited, and no number of airplanes acting on the defensive will prevent a determined pilot from reaching his objective.

4. *Factors of Success.*—The success of offensive tactics in the air depends on exactly the same factors as on land and sea. The principal of these are: (1) A choice of objectives which will play on the enemy's fears and force him to act on the defensive; (2) surprise; (3) the power of manoeuver; (4) effective use of weapons.

5. *Choice of Objectives.*—An aerial offensive is conducted by means of:

(1) Offensive patrols whose sole mission is to find and defeat the enemy's aircraft. The further the patrol penetrates behind the hostile front the greater will be the moral effect of the success they gain, and the more they will interrupt the work of the enemy's machines, while enabling ours to accomplish their missions without interference.

(2) By the attack with bombs and machine gun fire of the enemy's troops, transport, billets, railway stations, rolling stock and moving trains, ammunition dumps, etc. In this case, again, such raids may be expected to produce the maximum effect when undertaken against distant objectives, since they may cause the enemy to withdraw artillery and airplanes from the front for the protection of the locality attacked. They are also, however, of great use on the immediate front in connection with operations on the ground.

Every patrol or raid should, therefore, be sent out with a definite mission, the successful performance of which will not only help us to gain aerial ascendancy by the destruction of hostile aircraft, but will also either tend to induce the enemy to act on the defensive in the air, or further the course of operations on the ground.

6. *Surprise.*—Surprise has always been one of the most potent factors of success in war, and although it might at first sight appear that surprise is not possible in the air, in reality this is by no means the case. It must be remembered that the airplane is working in three dimensions, that the pilot's view must always be more or less obstructed by the wings and body of his machine, and that consequently it is often an easy matter for a single machine, or even a pair of machines, to approach unseen, especially if between the hostile airplane and the sun. Fighting by single machine is, however, rapidly becoming the exception, and surprise is more difficult of attainment by machines flying in formation.

Even when in view, however, surprise is possible to a pilot who is thoroughly at home in the air, and can place his machine by a steep dive, a sharp turn, or the like, in an unexpected position on the enemy's blind side or under his tail.

7. *Power of Manoeuver.*—Individual skill in manoeuver favors surprise, as pointed out above. Individual and collective power of manoeuver are essential if flying in formation is to be successful or even possible. They can only be obtained by constant practice.

The following points must always be borne in mind:

(1) Pilots and observers must know the fuel capacity of their machine, and its speed at all heights.

(2) The direction and strength of the wind must be studied before leaving the ground and during flight. This study is most important since wind limits the range of action, as machines when fighting are bound to drift down wind.

(3) To guard against surprise, direction must be varied frequently unless making for a definite point, and a good look out must always be kept in every direction.

(4) Every advantage must be taken of the natural conditions, such as clouds, sun, and haze, in order to achieve surprise.

(5) The types of hostile airplanes must be carefully studied, so that the performance and tactics of each, its blind side, and the best way to attack it, can be worked out. Some machines have a machine-gun mounted to fire downwards and backwards through the bottom of the fuselage.

(6) Height means speed, since it is easier to overhaul a hostile machine on a dive. If a hostile machine seeks safety by diving, it is bound to flatten out eventually and may, therefore, be overtaken by a machine from above, if the latter dives in front of it. The hostile machine must be watched all the time in case it turns.

(7) The engine must always be kept well in hand in a dive. If it is allowed to choke the opportunity will be lost.

8. *Effective Use of Weapons.*—The offensive weapons in use in airplanes are machine and Lewis guns and bombs. Machine and Lewis guns in the air, as on the ground, are very powerful weapons of offence, owing to the volume of fire they are capable of producing. Their effective use in the air demands even more skill and practice than on the ground and is dependent on:

(1) Absolute familiarity with the mechanism of the gun so that jambs can be rectified in the air.

(2) A high degree of skill in manipulation and accuracy in aiming, both on the ground and in flight.

(3) Constant study of the conditions affecting their use in an airplane, and continual practice under those conditions.

Skill and accuracy in bombing in the same way can only be acquired by continual practice and careful study of the conditions which govern the correct setting and use of bomb sights.

Such practice is best obtained by the use of the camera obscura, and must be carried out from varying altitudes up to 10,000 feet, from which height bombs will often have to be dropped on service.

Types of Fighting Machines.

9. *Existing Types.*—The machines at present in use for offensive purposes may be divided into three main classes: (1) Fighters, (*a*) single seater, (*b*) two seaters; (2) fighter reconnaissance; (3) Bombers.

10. *Fighters.*—(*a*) Single seaters are fast, easy to manoeuver, good climbers and capable of diving steeply on an adversary from a height.

Their armament consists of one or, sometimes, two machine or Lewis guns, whose axis of fire is directly forward, and, in some types, in a fixed position in relation to the path of the machine.

Single seater fighters are essentially adapted for offensive action and surprise. In defence, they are dependent on their handiness, speed and power of manoeuver. They have no advantage over a single seater as regards armament, and are at a disadvantage in this respect when opposed to a two seater, and, therefore, the moment they cease to attack are in a position of inferiority, and must break off the combat, temporarily at any rate, until they have regained a favorable position. On the other hand, provided they are superior in speed and climb to their adversary, they can attack superior numbers with impunity, since they can break off the combat at will in case of necessity.

(*b*) Two seater fighters have, in addition, a machine gun for the observer, on a mounting designed as wide an arc of fire as possible, especially to the flanks and rear. Their front gun or guns remain, however, their principal armament.

The two seater is superior in armament to the single seater, since it is capable of all-round fire, but is generally somewhat inferior in speed, climb and power of manoeuver. It has greater powers of sustaining a prolonged combat, being less vulnerable to attacks from flanks and rear, but as in the case of single seaters its chief strength lies in attack.

11. *Fighter Reconnaissance Machines.*—The first duty of these machines is to gain information. They do not go out with intent to fight, but must be capable of doing so, since fighting will often be necessary to enable the required information to be obtained. Those at present in use are two seaters, the pilot flying the machine and the observer carrying out the reconnaissance. They are seldom called upon to act alone, but fly in formation, one or more machines carrying out the reconnaissance, while the remainder act as escort, on the same principle as an escort on the ground. That is to say, they do not seek an engagement, but fight, if necessary, to enable the reconnaissance machines to do their work. They approximate to the two seater fighter type.

12. *Bombing Machines.*—Bombing machines may be single seater or two seater. Two seats are preferable, provided they can carry the

necessary weight, as they can, in case of necessity, undertake their own protection, even when loaded. Their requirements, as regards armor, are similar to those of fighter reconnaissance machines. Single seaters usually require an escort.

Formation Flying.

13. *Evolution of Formation Flying.*—The development of aerial fighting has shown that certain fundamental maxims which govern fighting on land and sea are equally applicable in the air. Among these are concentration, mutual cooperation and support, and a well organized system of command, under which no individual has more than a limited number of units under his immediate control. Adoption of formation flying has followed as an inevitable result.

Any mission which has fighting for its object, or for the accomplishment of which fighting may normally be expected, must usually, therefore, be carried out by a number of machines, the number depending on the amount of opposition likely to be encountered.

Flying in formation is, therefore, necessary in the case of (1) Offensive patrols; (2) reconnaissance, including photography, and their escorts; (3) bomb raids and their escorts; and is the normal method of carrying out these duties.

14. *Principles Common to all Formations.*—The formations adopted vary in accordance with the mission, and with the type of machine. Certain principles are, however, common to all formation flying.

(1) A leader must be appointed, and a sub-leader, in case the leader has to leave the formation for some reason, *i. e.*, engine trouble. The machines of leaders and sub-leaders must be clearly marked. Streamers attached to different parts of the machine are suitable.

(2) The leader cannot control efficiently more than a certain number of machines. If, therefore, this number is exceeded, the mission must be carried out by two formations acting in concert, but each with its own leader.

(3) An air rendezvous must be appointed, and the leader must see pilots and observers before leaving the ground and explain his intentions to them. Machines of each group should leave the ground together and arrive at the rendezvous in the correct formation of their group. When all machines have reached the rendezvous the leader fires a signal light, indicating that formation is to be picked up at once. He should then fly straight for a short time, as slowly as possible, while his observer, if he has one, reports on the formation. If one or more machines are rather far behind, the leader should turn to the right or left, after he or his observer has given a signal that he is going to do so. Thus the machine behind will be enabled to cut a corner and close up. When the leader is satisfied with the formation he fires a light signifying that he is ready to start. The actual signal to start can be given either by the leader or from the ground; in the latter case the officer on the ground, who is responsible for the despatch of the group, will also be responsible for deciding when the proper formation has been adopted. It is usually best for the signal to be given from the ground. The decision as to the suitability or otherwise of the weather conditions will rest with the leader of the formation. Signal lights must be fired upward by the leader, otherwise machines in rear may have difficulty in seeing them.

(4) Pilots must clearly understand how the formation is to re-form after a fight. Definite instructions by the leader on the point are

essential. A rendezvous over a pre-arranged spot has been found suitable, in the case of a small area. In the case of a large area two or more spots may be previously designated, the rendezvous to take place over the nearest. It must be realized that prearrangements may be found unsuitable, and in every case each machine must rejoin the leader at the earliest possible moment. To rendezvous successfully after a fight needs continual practice.

(5) Formations must not open out under anti-aircraft gun fire. It has been found by experience that fire is usually less effective against the well closed up group of machines than when directed on a single machine. To open out is to give the enemy the chance, for which he is waiting, of attacking the machines of the formation singly.

15. *Offensive Patrols.*—The sole duty of offensive patrols is to drive down and destroy hostile airplanes, and they should not be given other missions to perform, such as reconnaissances, which will restrict their fighting activities. In the face of opposition of any strength offensive patrols have to fly in formation in order to obtain the advantage of mutual support, but the formations adopted can be governed solely by the requirement of offensive fighting. Single seater scouts or even two seaters, if superior in speed and climb to the great majority of the enemy's machines, may be able to patrol very successfully alone or in pairs taking advantage of their power of manoeuver and acting largely by surprise but in the case of machines which do not enjoy any marked superiority formation flying is essential. Fighting in the air, however, even when many machines are involved on each side, tends to resolve itself into a number of more or less independent combats, and it has been found advisable to organize a purely fighting formation accordingly. Such a formation can consist of six to nine machines, organized in groups of two or three machines each, every group having its own subleader, the senior of whom takes command of the formation. A deputy leader should also be designated, in case the leader falls out for any reason. As far as possible the groups should be permanent organizations in order that the pilots may acquire that mutual confidence and knowledge of each other's tactics and methods which is essential for successful fighting. It must be impressed on pilots that the group is the fighting unit and not the individual.

Normally a formation should consist of not more than three groups, and if greater strength is required separate formations should be employed, acting independently, but in such a way as to be mutually supported.

A fighting formation should consist of machines of one type, but single and two seater machines can be combined if of similar performance. A suitable flying formation with groups of three machines is in column of groups, with flank machines echeloned slightly back, the whole formation being in vertical echelon, the rear group being the highest, and consisting of two seaters in the case of mixed formation, of machines of equal performance.

Fast single seaters if combined with two seaters should fly above them, circling so as to obtain a good view all round.

A similar flying formation in the case of groups of two machines is in line of groups, the two machines of each group flying one behind the other, the rear machine at a higher altitude. The flank groups should not be echeloned back, as in this position they will be unable to see the center group.

Fighting Tactics.

16. *Offensive Tactics.*—Fighting tactics vary with the type of machine, and with the powers and favorite methods of individual pilots.

(1) Single seaters: Although as a principle a single-seater should not act alone, yet in many cases isolated scouts will be called upon to fight single handed, *i. e.*, when a formation has become split up during a combat and a machine fails to rejoin its formation. Again, selected pilots on the fastest types of single seaters may be usefully employed on a roving commission, which will enable them to make the greatest use of surprise tactics.

In every case the safety of an isolated scout lies in attack, by surprise if possible, approaching either from a direction of the sun or from the enemy's blind side. When surprise is impossible, advantage must be taken of the handiness and manoeuvering power of the scout to prevent the enemy from taking careful aim by approaching him in a zigzag course, and never in a straight line since a machine attacking in a straight line offers a comparatively easy target. When within about 100 yards the zigzag course must be abandoned, and the moment when the enemy is in the act of shifting his aim should, if possible, be chosen. He can then be attacked in a straight line with a burst of rapid fire, or it may be possible to place oneself below him and fire at him more or less vertically at almost point blank range.

To open fire at long range is to give the advantage to the enemy, since it is necessary to fly straight to bring fire to bear, and an easy mark is thus offered. It is useless to fire at more than 200 yards as the target given by a machine at that distance is about one by two feet, and from the side, perhaps two by ten feet, so that one can realize the uselessness of opening fire at long range.

When it is necessary to swerve to avoid a collision or to break off the combat temporarily to change the magazine or rectify a jamb, this should be done by a sudden turn or climb, care being taken subsequently to avoid flying straight or losing height. When ready a favorable position must be regained by manoeuver before renewing the attack.

If surprised in an unfavorable position it is by no means easy to shake off the adversary. If time permits it should be the invariable rule to turn and attack before he comes to close quarters. If, however, he succeeds in doing so the best chance lies in a side slip, or a fall out of control. A turn will expose the broad side of a machine to his fire, while to dive straight away is to court disaster.

Surprise can often be attained by carefully watching the adversary, preferably from behind. An especially favorable opportunity for surprise occurs in the case of a hostile machine crossing our front on some special mission, for once the hostile observer has satisfied himself that the air is clear, he will give his principal attention to his work. The enemy will often choose cloudy weather for such missions, and this gives special chances of surprise to a skillful pilot, working with intelligence. In such weather it must be remembered that it is often of advantage to approach the hostile machine on his own level when the planes form but a thin line which is difficult to see.

In the case of single seaters acting in pairs, or in groups of three, surprise will be more difficult and success must be sought in close cooperation, and in boldness of attack. If the enemy is inferior in numbers an opportunity will occur for a converging attack by two machines

against one; but the attacks must be simultaneous, so that the enemy cannot engage the machines singly. Another method is to attack echeloned in height, the lower machine diving and attacking the enemy from behind, while the upper machine waits an opportunity to swoop down on him when he turns to engage the machine that attacked first. The latter method is preferable in the case of two single seaters, since, if both machines attack on the same level, they run the risk of being themselves surprised from above. For this reason groups are, generally speaking, better composed of three machines than of two. An attack of equal numbers will usually resolve itself into a series of individual duels. In attacking superior numbers success lies in the destruction of the enemy's morale by excessive boldness.

Decoy tactics are sometimes successful. One or more machines attempt to draw the enemy on to attack, while others fly high above them, ready to surprise the enemy should he seize the apparent opportunity. Watch must be kept for similar tactics on the part of the enemy.

When fighting in formations of one or more groups, the fighting unit should be the group, each selecting its own objective and acting as described above. The groups will often become separated, but every effort should be made to retain cohesion within the groups, by fighting inwards toward the leader. If the enemy machines scatter, attention should be concentrated on those lagging behind; and, if they dive and are followed down, at least one group should remain at a height as a protection from surprise.

The dangerous quarter in the case of a formation of single seaters is the rear, and care must always be taken to keep a constant watch behind and above.

Fighting in formation with single seaters is a most difficult operation and demands constant study and practice, the highest degree of skill on the part of the individual pilots, mutual confidence between them, and intimate knowledge of each other's methods.

Airplane Fighting in Single Seater Scouts.

1. *Characteristics of the Single-seater Scout.*—The single-seater scout is fast, very easily handled, a good climber, and capable, owing to its qualities of penetration through the air and the stoutness of its build, of diving with great speed on an adversary. Its armament consists of a machine gun whose axis of fire is directed forward and in a fixed position in relation to the machine. Sometimes a second gun is carried; its axis of fire is parallel to that of the other gun. Thus equipped, the machine is best fitted for attack. For defence it chiefly relies on its speed and power of manoeuver.

Its field of view upwards and downwards is only fairly good; constant attention and much practice are required to keep other machines concerned, friendly or enemy, in sight during the movements of an engagement.

2. *Qualifications of Single-seater Scout Pilots.*—None but specially selected pilots are capable of flying these machines. A high standard of physical fitness is essential. The heart, lungs and ears are subject to great strain, for pilots, in the course of their flights and fights, are called upon not only to climb very high (15,000 feet or over), but also to undergo great, sudden and frequent changes of altitude. Eyesight, too, must be excellent; otherwise the enemy's machines will escape, and the pilots

themselves will be open to surprise, or may attack friendly machines, a mistake that is easily made.

Pilots must give constant attention to increasing their skill not only as pilots, but also as machine gunners, and to keeping their machines and guns in fighting trim. Important as are self-control and courage in action, an attack to be successful must be thoroughly thought out. The chief characteristic, however, of a fighting pilot, is a fixed determination to bring down the greatest possible number of adversaries.

3. *Fighting Tactics of the Single-seater.*—As a general principle a single-seater should never cruise alone, and an attack by an isolated single-seater should be the exception.

If the pilot, instead of confining his attention to the sky, allows it to be diverted to examining the ground, he may be easily surprised. A single-seater pilot should make a point of collecting useful information in his flights, and for this he will, as a rule, have many opportunities, for it is only rarely that the enemy aviation will be so active that it will claim his entire attention.

The principle on which the isolated single-seater fights is surprise, which is only made possible by keen observation, coolness, patience and experience. Surprise, moreover, is daily becoming more difficult, as enemy machines are now often warned of the presence of our scouts by observers from the ground who fire very visible, generally on the dangerous side, smoke balls that are very easily seen. If the enemy are numerous chance of surprise is small, and the attack not only will be deprived of this element of success, but also will lack the impulse which springs from the consciousness of superiority of force.

In frequent cases isolated machines will be called upon to fight single-handed, *i. e.*, (*a*) when enemy machines have penetrated our lines, for every machine which crosses our lines must be destroyed at any price; (*b*) when for some reason or other a formation has been broken up and its elements have failed to join other formations.

4. *Scout vs. Scout.*—The fight of Scout vs. Scout is a struggle either to obtain position behind the enemy's machine in prolongation of its axis, or if he is faster in manoeuvering, to prevent him obtaining a favorable position for firing. The manoeuver for position often takes a very long time without either machine being able to fire at the other.

5. *Scout vs. Single, Double, or Multi-seater Machine.*—Principle: act by surprise. When this is not possible, manoeuver so that the enemy cannot direct his fire properly. To carry this principle into effect it is essential (1) to observe the adversary; (2) to approach without being seen, and (3) to give the enemy no opportunity for adjusting his fire.

(2) Observe the adversary.—Very often the adversary has a mission to fulfill, *i. e.*, ranging, photography. The time to attack is when he is engaged in carrying this mission out. For instance, a hostile machine is seen to approach the line in uncertain evolutions. Generally on such occasions he begins by observing the sky. Eventually, reassured by his inspection, he makes up his mind to fly across the lines and to undertake his mission It is when thus occupied that he is open to surprise.

Again, a machine may be seen cruising, apparently without any special mission that requires his undivided attention to the ground. On such occasions it is often better to watch him for some time from afar until his attention slackens and his evolutions become less regular. Then is the time to effect a surprise.

(3) Approach without being seen.—As a general rule place yourself between your adversary and the sun; then, according to the height of the sun, dive on him or make your attack on his own level. If there is no sun, an opportunity of surprising him often arises in the course of his evolutions, by getting behind him, in prolongation of his axis or slightly below it. Such a form of attack is especially applicable when manoeuvering in enemy country, for then the hostile observer is not so much on the alert, and, in order to shelter from the wind, is likely not to put his head over the fuselage to keep watch. If he observes at all, it is only the air above him.

When a scout is far over the enemy's lines and sees a hostile machine rise from its airdrome, climb for height, and make for the line, with the probable intention of carrying out a reconnaissance—indications of which are his high altitude and clearly marked direction—a chance of surprise is offered, provided the scout follows the hostile machine close and in the same vertical plane, but on a slightly lower level, where he will be hidden by the tail piece of the hostile machine from the enemy's crew. When within some three or three and half miles of the lines, the enemy will cruise for a brief period to see that the air is clear; he will then go straight to his objective. This is the time for attack, for both pilot and observer, reassured by their observations, will be keeping a look-out forward. In cloudy weather, as an airplane forms but a thin and barely visible line, it is generally an advantage to approach the enemy on his own level.

(4) Do not let the enemy adjust his fire.—If the enemy attempts to fire, do not fire yourself, and do not make for him in a straight line, for a cool gunner firing at a machine making straight for him, has the greatest chances of hitting it and bringing it down.

Make for your opponent in a zigzag course which obliges him to change the aim of his gun from side to side. Keep also a little above him and as you approach get ready to start firing; then when about 100 yards off, and the conditions are favorable, *i. e.*, when the enemy gun is still pointed to port, and you yourself have turned and are already slightly on the starboard side, charge straight at him, firing a rapid burst. The shots should be fired at about 50 yards from the target. Under these conditions 15 to 50 rounds can be fired, after which you swerve so as to avoid a collision.

If the enemy is not brought down, sheer off quickly to the rear by a sudden turn or loop; be very careful to keep tacking, with sharp turns, and avoid losing height. As soon as you are again in a position repeat the attack in the same manner. In these attacks it is needless to make any corrections for range on account of the relative speed of the machines, as the courses of the two machines are parallel during the firing and the distance is small.

Some pilots, instead of charging the enemy after this method, approach him within a hundred yards in one of his blind sectors, and then by a sudden loop get into a position to shoot him from behind. This manoeuver requires a great knowledge of the enemy machines and plenty of training, for it must be carried out with extreme precision. It cannot be recommended for general adoption.

In any case single-handed attacks by single-seaters require a coolness, a gift of observation, a familiarity with the gun and a skill in manoeuvering which are possessed by only first-class pilots. Naturally the attack of two double-seaters by a single-seater requires very special qualities of judgment, for it must be very accurately timed. The prob-

lem is comparatively simple when the group of enemy machines is within our lines, the machine farthest from the line must then be vigorously attacked.

6. *Battle Teams.*—The normal battle units is a group of two machines; a third machine may join them if needs be. The constitution of such units is a matter which requires particular attention of a Squadron Commander. An essential condition of success is that a team be homogenous; consequently the machines must be of the same type or at any rate equivalent in speed and capacity of manoeuver. But above all the two pilots of a team must have mutual trust in one another's courage, skill and judgment. A single-seater squadron, should, therefore, be composed of none but first-class pilots.

7. *Co-ordination of Movements in a Team.*—The teams always manouever in accord. One of the two pilots is appointed before the flight to take the lead, the other co-ordinates his movements to those of the guide's. As a principle the machines never fly more than 400 yards apart, the one in the rear slightly higher and in echelon. Normally the two machines fly at low speed.

If the leading pilot sees his comrade suddenly move away by a sudden increase of speed, a change of course, a climb or dive, he must follow in order to find out the cause of this evolution—*i. e.*, attack by enemy airplane, heavy A. A. fire—and it is only after the reason no longer exists that he resumes his part as guide. Except in cases of urgency, no movement that would break up the team should be made by either machine without first signalling "Attention" to its comrade; the signal for this purpose will be a violent and continual lateral swinging of the machine. To ensure that the signal is seen, the machine which makes it must put itself in a position where it can be seen by its comrade; the latter will repeat the signal as soon as it is seen.

8. *Attack of an Isolated Enemy Machine by a Team of Two Scouts.*—In this case surprise is not essential. Faced by a combined converging attack the enemy is likely to lose his nerve. While he is engaged with one machine he is attacked and driven down by the others. Two methods are recommended:

(1) The attack on both sides.—The two scouts first obtain a position above the enemy, and, if possible, with the sun behind them. They then increase the distance between them from 600 to 800 yards, following at the same time the movements of the enemy. They next increase their speed and dive on him simultaneously. At 100 to 50 yards from him they open fire. When the enemy prepares to fire at one of the attackers the latter closes on him, carefully tacking to avoid a straight course, but remaining on the side from which his attack started; meanwhile the other scout closes in and fires at leisure.

This manoeuver requires a very high measure of co-operation between the two pilots, for it is absolutely necessary for them to approach simultaneously so that the enemy cannot shoot first one and then turn on the other.

(2) The attack on a vertical line: One of the machines dives into a position 150 yards behind the enemy in the blind angle of its tail piece, and opens fire at this range if sure of his aim; his comrade dives in the same vertical plane, keeping 100 yards higher than the first, and fires point blank. The enemy's defense will generally consist in an attempt to circle round the lower scout and shoot him in the process. The scout must manouever so as to keep behind all the time. While the enemy

thus tries to shoot the lower scout the upper one has ample opportunity to swoop down on him and shoot him point blank. Very often the lower scout will not even need to open fire at all.

This manoeuver is one of the easiest to co-ordinate well.

9. *Attack of Two Enemy Machines by a Team of Scouts.*—This attack resolves itself into two distinct duels of scout versus scout, each scout diving on one of the adversaries. It would appear at first sight that such attacks can be executed only by pilots of exceptional capacity; but in practice it will be found that the enemy team breaks up under the threat of attack. The scouts must then converge at once on the hindmost machine.

It often happens that, of the two enemy machines, one is entrusted with a mission, *i. e.*, ranging or photography—while the other simply protects the first. In this case the protecting machine usually stays within its line to cover the retreat of the other, which goes out alone to the point necessitated by his mission. The scouts must of course attack the protecting machine while the other is busy, and then settle the latter's account. With these objects close observation of the doings of the enemy is essential.

10. *Engagements of Several Teams of Two Scouts.*—If the scouts are equal in number to the enemy machines, the teams attack each team for itself, as explained above. As often as not, however, the enemy scatters before such an attack; some take to flight and the scouts must then co-ordinate their movements so as to concentrate their efforts on the machines lagging behind.

If the scouts are superior in numbers, the teams which are in the less favorable positions for an attack owing to distance, bad position of the sun, etc., must attract to themselves the enemy's attention and, while watching the fight, be ready to help any of our machines in a difficulty, or to intervene if any opportunity offers. A careful watch must be kept for hostile reenforcements which might turn up unperceived and attack the scouts while they manoeuver. In short, the surplus teams form a reserve and a guard.

If a group of enemy machines, instead of scattering, make a stand before the attack of a group of scouts, it becomes necessary, according to the circumstances, either to engage in a fight to the last or to force the enemy to scatter by means of a turning movement on the part of the surplus teams. In any case any faint-hearted demonstration, particularly if far behind the enemy lines, must be avoided.

11. *How to Manoeuver One or More Groups of Teams.*—The number of teams that can manoeuver properly together is three (*i. e.*, six machines). A group of scouts beyond that number is difficult to handle, and it is better to form several groups working independently. One of the team Commanders is Group Commander; the other Commanders conform to his movements after having been warned by the signal "Attention." From one group to another the only means of signalling is by flares. Each Group Commander should therefore be provided with a signalling pistol. The signals by flares should be settled beforehand. No general code can now be laid down.

12 *Departure and Assembling of Groups.*—As a principle the two machines of a team leave the airdrome together and land together. They go straight to the starting point. The group, on the contrary, meet at a starting point chosen above the lines, for there would be a waste of time if all the machines were to leave the same airdrome

together. When two or more groups have to carry out flights simultaneously, they must have different starting points and must fly at different altitudes between 7,500 and 15,000 feet

13. *Rallying Points of Groups.*—A group of scouts is almost always scattered after a fight Immediately after the engagement it goes to its starting point to reform; and this is also its rallying point.

(2) Two Seaters.—The principles of fighting in two seaters are similar to the above, but in actual combat they are able to rely more on their power of all-round fire and less on quickness of manoeuver. The fighting tactics adopted should, therefore, be such as to favor the development of fire. The single seater, when no longer able to approach its adversary, temporarily loses all power of offense and has to manoeuver to regain a favorable position. The two seater, on the other hand, can develop fire from its rear gun, after passing its adversary or on the turn. This, however, only applies partially in the case of pusher types, whose fire power to the rear is comparatively feeble

A two seater, like a single seater must, however, never dive straight away from an adversary, as even though it can fire to the rear the advantage is all with the machine which is following.

Formations of two seaters are less liable to surprise from the rear, since the observers of the rear machines can face in that direction and keep constant look-out. Mutual fire support is also easier in their case, in view of their all-round fire. They are, therefore, as already pointed out, better able to sustain a protracted battle. The essence of successful fighting in two seaters lies in the closest cooperation between pilot and observer. They must study their fighting tactics together, and each must know what the other will do in every possible situation.

The essence of fighting in the air is to attack first, whether in the case of single machines or formations. In addition to the moral ascendancy gained by offensive tactics, the material advantage in aerial fighting is with the attacker. Every machine has its blind side and is more or less vulnerable to attack from one direction or another; the initiative is therefore of primary importance. Attack by formation is usually initiated by the leader or by a machine on the flank. All the machines should concentrate on the leader's opponent. This has a great moral effect and prevents our formation from splitting up.

The quickest way of breaking up a hostile formation is to attack the leader. When on escort duty a machine attacked should not be followed down, but the formation should concentrate against a second machine as soon as one has been driven off. When on fighting patrol machines should be followed down when the enemy's formation has been broken up, but one of two or our machines must remain at a height to look out for other hostile machines attacking from above.

NOTES ON FOKKER FIGHTING.

By an F. E. 2B Observer.

One Fokker will fly about 150 feet below you, and about 300 to 400 in front, just far enough to keep your constant attention on him, but yet making it a somewhat bad target to shoot at, owing to the long range.

Whilst you are busily engaged watching this machine, you are often surprised to find that a second Fokker has apparently appeared from nowhere—like a "bolt from the blue"—and is diving at your tail

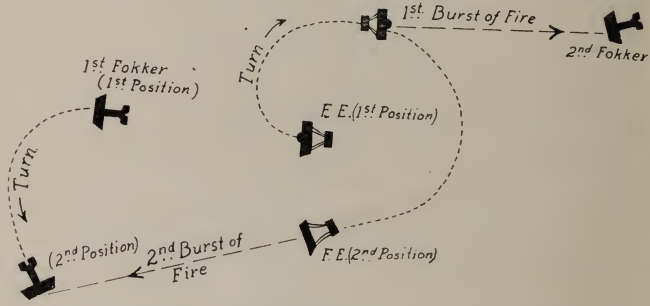
somewhere about 150 m. p. h., firing his gun all the while. Only naturally you will turn to try and check this attack, and in doing so, lose sight of the Fokker that was in front of you

This machine will turn and climb, with the result that while you are engaging the machine you turned to meet, this other Fokker will come and pounce on your tail. You turn, in all probability, to try and check this dive; with the result that you get a series of dives from the rear.

Each time you will notice that when you turn to engage the machine that is diving at you, your other opponent clears off behind you and climbs again; then he dives, and so it goes on.

The following tactics are suggested:

You observe a Fokker flying in front and below you. A hundred chances are that there is another one making his way round to your rear, probably in the clouds. If possible get in a good burst at the



Hun in front of you, and then immediately afterwards make a sharp right-about turn. If you observe another Fokker as you turn, get in a burst at him, turn again immediately and dive after the Fokker that was in front of you, because, in all probability, the Fokker flying in front of you, hearing you open fire again, will turn and commence to climb, so as to be able to dive at you as described before.

It is general information, I believe, that nearly every Fokker pilot makes a left hand turn whenever possible, rather than a right. As an F. E. 2B is capable of turning twice as fast as a Fokker can, by the time you have turned sharply round, fired a burst at the Fokker overhead, and turned off to the right again, the Fokker that was in front of you—a hundred chances to one—is making a left turn, with this result: As you complete your right turn, the Fokker will be broadside to you, with the result that you catch him at a decided disadvantage, because he cannot use his gun, as he fires it through the propeller.

The result of the fight, or rather, the success of the fight, when it reaches this stage, depends upon the ability of the F. E. pilot and quick thinking. The F. E. has a distinct advantage in being able to turn sharply with safety, whilst the Fokker *must turn* slower, so losing his good position—if he had it in the first place.

If it was an engagement with a single machine, I should propose doing the same thing if you happened to come across a Fokker flying below and in front of you. Of course, you are not to know that there is not

another machine behind, so I propose that, after firing a burst at him, turn round as before, but of course, as you see nothing, continue to make a complete circle, thus catching the Fokker broadside.

17. *Reconnaissances.*—In reconnaissance the whole object is to protect the reconnaissance machine or machines, and enable them to complete their work. Opposition will usually take one of two forms. The enemy's scouts may employ guerilla tactics, hanging on the flanks and rear of the formation, ready to cut off stragglers, or attacking from several directions simultaneously; or else if the formation may be attacked by a hostile formation. A suitable type of two seater fighter reconnaissance machine will often be able to deal with either class of opposition without assistance. The machines must fly in close formation, keep off enemy scouts which employ guerilla tactics by long range fire, and be ready to attack a hostile formation if the enemy's opposition takes that form.

Reconnaissance formations, like fighting formations, can be organized in groups, each with its sub-leader, but as the object is to secure the safety of the reconnaissance machine, the whole formation must keep together and act as one.

If scouts are used in combination with two seater machines on a reconnaissance, it is usually preferable to keep the two types of machines as distinct formations, each under a separate leader. The two seaters act as described, and the scouts fly above them in such a position as to obtain the best view of them and the greatest freedom of manoeuver in any direction. Their role is (1) to break up an opposing formation; (2) to prevent the concentration of superior force on any part of the reconnaissance formation; (3) to assist any machine which loses formation through engine or any other trouble.

A suitable formation in the case of six two seater machines has been found to be two lines of three, the flankers in the front being slightly higher than the center (reconnaissance) machine and the three machines in the rear slightly higher again. The intervals between the machines should not be more than 100 yards, and the distance of the rear rank from the front should be sufficient only to admit of a good view being obtained of the leading machines.

The pace must be slow, otherwise the rear machines are bound to straggle. Machines must, therefore, fly throttled down. Sharp turns by the leader also lead to straggling. A signal, therefore, should always be given before turning, and a minute or two allowed, if possible, after giving the signal before the turn is commenced, in order to give the machines on the outer flank time to gain ground.

18. *Bomb Raids.*—A bomb raid in the air may be compared to a convoy on the ground, and similar measures are required for its protection, namely, an escort designed to act offensively and keep the enemy at a distance, and, in addition, an escort keeping with the raid for the local protection of bombing machines, should the enemy succeed in getting to close quarters.

The duty of the bombing machines is to get to their objective and to drop their bombs on it, and the duty of the escort is to enable them to do so, and only to fight in the execution of their duty. The bombing machines, like a convoy, must keep in close formation. Any tendency to straggle or to open out under anti-craft fire will render the task of the escort impossible. When near their objective the machines must get into a formation of line ahead in order to drop their bombs, but a rally-

ing point must always be chosen beforehand where they will collect and resume flying formation as soon as their bombs have been released.

An escort to a bombing raid may be suitably composed of single seater and two seater fighters, the latter being disposed round the bombing machines so as to protect them, especially on the flanks and rear, while the single seaters fly above the formation.

The single seaters constitute the offensive portion of the escort, and can be reinforced, if necessary, by some of the two seaters, but a portion of the latter must invariably remain with the bombing machines as local escort.

Bombing machines, two seaters and single seaters, will each require their own leader. The leader of the bombing machines should take command of the whole when flying as one formation.

The secret of success in bombing operations is the most careful pre-arrangement, so that every one knows exactly what he has to do.

When a very large raid is contemplated, it will often be best to carry out the attack by two separate formations, since there is a limit to the number of machines which can be controlled sufficiently by a single leader. Eight to ten bombing machines are normally the maximum. The departures of the two formations from their respective rendezvous, if they are to make a single raid, should be so arranged as to enable them to give one another mutual support in case of a heavy hostile attack. The rendezvous should not be too close together, ten to fifteen miles apart is a suitable distance. Departures from the rendezvous should be timed so that the first formation is leaving the objective as a second approaches, and the leaders should watch each other's signals. As soon as the bombing machines of the first formation have recrossed the line, the escort should turn back and assist the second formation, which is likely to bear the brunt of any hostile attacks.

While the bombs are being dropped, the escort should circle round above the bombing machines, protecting them from attack from above, and ready to dive onto any hostile machine that may interfere with them.

When bombs have to be dropped from a low altitude as in the case of an attack on trains, a portion of the escort should be specially told off for the protection of the bombing machines.

The above is merely suggested method of carrying out a raid on a fairly large scale. Raids will often be carried out by a single type of machine, some carrying bombs and others acting as escort, and the formation adopted will vary with the number and type of machine available, the distance of the objective, and the opposition expected. The principles, in every case, however, remain the same.

Destruction of Material.

1. All bomb-dropping must be closely coordinated to the military situation. Sustained and systematic attacks may have considerable influence on the whole operations, but spasmodic and independent efforts can lead to no good result, and entail the expenditure of energy which could be more profitably devoted to other objectives.

2. Bomb sights should always be used against all targets. To obtain a high degree of accuracy involves the expenditure of much care and time on the part of even a highly-trained and skillful operator, but this is not necessary in the case of targets of large area, such as manufactories covering 10 to 12 acres, when a rapid use of the sights will give sufficiently accurate results.

In the case of objectives of small area, one of three methods may be adopted to obtain effect: (*a*) The deliberate use of bomb sights; (*b*) dropping bombs from a low altitude; (*c*) the despatch of a large number of airplanes in the expectation that some of the bombs may hit the target.

(*a*) In order to obtain good results from the use of bomb sights, the airplane may be obliged to spend considerable time over the objective. The problem of dropping bombs accurately is not similar to aiming in the case of a firearm, which can be elevated and trained.

For a given height there is one point in space, and only one, where the bomb must be released if it is to hit the objective, and to this spot the airplane must be brought. A slight miscalculation will mean that it passes to the right or left, and in such a case the pilot must turn round and repeat the operation until the flight path of his machine passes exactly through the required point.

This may require as much as an hour during which time the pilot should be free to manoeuver at will without being hampered by the presence of other airplanes carrying out the same enterprise. The deliberate use of bomb sights will therefore preclude the simultaneous use of several airplanes, and in order to insure considerable destructive effect in small areas machines must come down low so as to avoid the necessity for the deliberate use of bomb sights.

It should also be noted that if several airplanes are sent at intervals of an hour or more to the same objective, they will have to follow the same line; the enemy will be warned and may have guns ready laid to fire at the later arrivals.

(*b*) Dropping bombs from a low altitude involves considerable risk, and may lead to the airplane being shot down before the mission is accomplished. Although this method should, as a rule, only be made use of in the case of objectives unlikely to be strongly defended, the situation may be such as to demand its adoption in spite of the probability of heavy casualties, and the operation must then be regarded as being equivalent to a cavalry charge or an Infantry assault.

3. The most effective form of attack is to hamper the enemy's operations by bombing railway trains, and railway or road bridges.

Such action may either hinder the movement of reinforcements, ammunition or supplies in a limited area in which a tactical decision is being sought, or cause interruption of traffic on the enemy's line of communication such as may during a critical period of the campaign influence the general situation.

Hostile headquarters, ammunition and gasolene depots, transport parks and aircraft sheds form possible objectives. Attacks on railway junctions or detraining stations are unlikely to cause more than temporary inconvenience.

4. The destruction of material, and especially the despatch of expeditions against any particular target, should not be undertaken without reference to Flying Headquarters, in order that the latest information as to the target may be obtained.

It is advisable as a rule to reconnoiter the objectives selected for attack before such operation is carried out. If possible they should be photographed by the aerial reconnaissance so that the pilot of the attacking machine may be provided with pictures showing the appearance of the objective as seen from the air.

Attack of Troops.

5. The attack of troops on the ground may be undertaken at the discretion of the pilot, provided always that sufficient care is exercised in avoiding the attack of localities where any considerable injury is likely to be inflicted on peaceful inhabitants.

6. The weapons which may be employed are: (1) Machine guns; (2) steel arrows; (3) bombs containing high explosives.

The weight which can be carried in addition to the observer is small, and consequently the loss inflicted on the enemy will be less than if the pilot undertakes the attack alone with a full load of bombs; but it may sometimes be advantageous to carry out this form of attack in conjunction with reconnaissance.

7. The best results may be expected to be obtained during a pursuit when the moral effect is greatest, and when troops crowded on roads or at defiles offer good targets. Observers will note and report suitable opportunities for this form of attack.

G. Action of Airplanes when Fired at by Anti-Aircraft Guns.

1. When fired at by anti-aircraft guns an airplane can—(*a*) Change its altitude, viz., dive 100 feet or more; (*b*) change its direction sharply; (*c*) combine (*a*) and (*b*).

2. If the previous course is persisted in, changes of altitude offer little or no difficulty to the guns, as they are allowed for and corrected instantly by the sights. Sharp changes of direction, however, completely upset the prediction and cause all the shell already fired to be wasted. It is a question entirely of flight of shell. At a range of 5,000 yards the shell takes, approximately, 15 seconds to arrive. When firing it is, therefore, necessary to give sufficient deflection to the gun so that the shell shall meet the path of the airplane in 15 seconds time. If the airplane turns at right angles to its path, all the shell then in the air (about 8) are wasted and a new prediction has to be made which can be as easily upset by repeating the manoeuvre before another 15 seconds elapse.

3. A change of altitude combined with a change of direction is so slight an improvement on change of direction alone, that it is probably not worth losing altitude for.

4. The airplane should, when possible, keep between the anti-aircraft guns and the sun.

Instructions for the Attack of Airships by Airplanes.

1. Whenever possible, not less than two airplanes should be sent to attack an airship. At least one of the airplanes should be armed with bombs or a grapnel.

2. The actual attack of the airship will be made by the airplane armed with bombs or grapnel.

3. It is the duty of the other airplane engaged, to cover the attack by directing machine gun or rifle fire on the armament and personnel of the airship, particularly on any armament or personnel that may be on top of the envelope.

4. When bombs are used, the attacking airplane should endeavor to approach the airship from behind, and travel toward the bow, at a sufficient low height to secure effective aim. Immediately after drop-

ping a bomb, the attacking airplane should turn sharply at right angles to its course.

5. When grapnel is used, the attacking airplane should endeavor to approach the airship from behind, and slightly from one side. When in a suitable position, the airplane will turn across the beam of the airship.

6. In the attack of an airship at night, an airplane should endeavor to get below the airship and rake it by means of machine-gun, or rifle fire.

7. If an airship is escorted by airplanes, a sufficient number of airplanes must be despatched to engage both the airship and its escort. Preliminary instructions will be given to each pilot. It will be the duty of these airplanes not actually engaged in the attack on the airship itself to prevent interference by the hostile escort.

CHAPTER III.

OBSERVATION AND COMMUNICATION.

General.

1. Observations from airplanes can be carried out by the pilot single-handed, but, as undivided attention is necessary for observing, it is usually advantageous to carry a passenger who is free to devote his whole attention to this task.

The observer requires air experience and special training. He should have good eyesight, and possess sufficient military knowledge to enable him to recognize units of all arms in their various formations, and to be able to discern the most possible places in which to search for them.

He should be able to send and read the Morse code, and know how to use the aero automatic camera.

2. Before leaving the ground the observer will ascertain that everything he requires for making and recording observations is conveniently arranged and firmly secured against interference by the wind.

The following articles are essential:

(*a*) *Map.*—The map will be arranged so as to embrace the whole area over which the flight is to be made, without requiring readjustment whilst in the air. The scale of the map will vary with the nature of the reconnaissance. If much detail is required and a large scale map is necessary, a small scale map will also be taken so as to direct the course to and from the area to be examined, and to re-discover the position in the event of running into mist or cloud.

Maps may be carried in map cases or gummed on to cardboard or boards.

(*b*) *Note Book.*—Careful arrangements must be made for taking notes. A drawing block, about 5 by 10 inches, or a piece of smooth board with foolscap secured to it are useful methods. Loose pieces of paper soon become torn and lost.

The pencil should be secured by string to the writing block.

(*c*) *Field Glasses.*—Field glasses are necessary for observation Those which have been found best for the purpose are about 6 or 7 power.

The glasses should be hung round the neck ready for use.

(*d*) *Wrist Watch.*—The watch should be fitted with a strap sufficiently long to buckle round the arm outside the leather coat.

(*e*) *Wrist Compass.*—A wrist compass is very useful, even though in some types of machines it is possible for the observer to see the pilot's instrument. It should be fitted with a strap long enough to buckle on the arm over leather clothing.

No written matter or maps will be carried in an airplane which could give information to the enemy in the event of their falling into his hands.

3. Owing to the great cold experienced when flying in most types of airplanes, it is essential that observers should be warmly clad before starting on reconnaissance. The extra clothing worn may be uncomfortable on the ground, but it is not superfluous when travelling at 60 or 70 miles per hour at 6,000 feet.

The following articles of clothing are recommended:

Coat and Trousers.—A leather coat and overall trousers lined with wool. If these are not available, a good substitute is a wool knit jacket, with a waterproof or oilskin worn over it. An unlined leather coat should not be worn without a wool jacket underneath it.

Cap.—A leather cap with ear flaps which can be tied underneath the chin, or one, or better, two close fitting woollen caps.

Helmets.—An aviation helmet should be worn over the cap.

Goggles.—A good pair of goggles are indispensable.

Muffler.—A woollen muffler which, in addition to keeping the neck and chest warm, helps to hold the helmet in place.

Waistcoat.—A warm woollen waistcoat with sleeves.

Drawers.—One or two pairs of long thick drawers.

Boots.—A pair of loose fitting boots and at least two pairs of socks. Rubber overshoes should be worn in order to avoid the feet being wet before getting into a machine. It is most important that the boots should not be tight. If the weather is really cold, boots, which may be perfectly comfortable for marching in, may yet be sufficiently tight to interfere with the circulation and cause frost-bite. If the boots feel at all tight with two pairs of socks, one pair only should be worn.

Gloves.—A large pair of gloves, with woollen ones underneath are comfortable, woollen gloves worn alone do not keep out the wind. If the gloves are too thick, the observer will find it difficult to make notes in the air. Big gloves can be pulled off when notes have to be made.

Note.—Vaseline is useful for the hands and feet as a protection against the cold.

4. On receipt of orders for a reconnaissance the pilot and observer will consult together, with the aid of a map, as to the best manner of fulfilling their task.

In deciding upon the course to take the following points should be weighed: (*a*) The speed and climbing power of the airplane; (*b*) the strength and direction of the wind; (*c*) the position of the sun and the state of the atmosphere.

It is much better to gain height on the way to the starting point of a reconnaissance than to climb over the aerodrome, and then waste time flying against a strong wind on the way out. The position of the sun affects observation to a great extent. Frequently during the first two hours after sunrise there is a thin, high mist which makes it impossible to see anything eastwards.

When very strong winds are blowing a little ingenuity in planning the course may enable a successful reconnaissance to be carried out.

The height at which observations could be made depends on the military situation and the state of atmosphere.

Having decided the course, compass bearings, times and distance will be worked out and, if necessary, posted in the machine so as to be clearly visible during flight.

5. If the area is new to the observer a very careful study of the map before starting must be made, since the less he has to take his eyes off the ground to study his map the better.

A previous knowledge of the country to be reconnoitered, gained either on the ground or from the air, will render the task of the observer much easier.

Time expended in studying the map and noting the main features of the country over which the reconnaissance is to be made is never wasted. The relative position of railway stations, sidings, market places and the shape of woods, etc., should be carefully noted.

The responsibility of finding the way must be shared by the pilot and the observer. It is inadvisable to lay down any definite rules as to their respective duties. Mutual confidence is of utmost importance and it is therefore advantageous for the same pilot and observer to work together as far as possible.

The pilot must know the exact nature of the information required so that he can handle his machine to enable the observer to see what he wants. An experienced pilot sometimes sees a number of things which the observer may miss, and he must always point them out.

As the attention of the observer is necessarily absorbed by his work in watching the ground, it is the special duty of the pilot to keep a lookout in the air for hostile aircraft. Communication between the pilot and observer is necessary. A speaking tube is the best, but if none is available a code of signals must be arranged so that the observer can communicate his wishes.

6. The observer should be quite clear as to his task, and he must keep his attention fixed exclusively upon it. The difficulty is not so much to see things as to know where to look for them. He should, therefore, be in close touch with the situation, carefully study the map, and then apply his military knowledge in deciding the most likely places to be searched for the information he requires. It is not sufficient merely to look at the country, the eyes must constantly travel from likely spot to another, and any place which offers a hint of matter for report, must be carefully examined with glasses.

Natural objects are easily mistaken for troops or transport. In order to avoid falling into this error the observer should familiarize himself with natural objects on the ground and note the agricultural features of the country over which he is working.

The observer should not try to estimate the road space covered by a column, but will report the position of the head and tail with reference to the map. Care should be taken (1) not to mistake the head of the advance guard for that of the main body; (2) not to include the transport in the fighting troops. Every endeavor must be made to discover whether the enemy is marching at increased distance to deceive the observer as to the length of the column.

When the head of the column is approaching a road junction, it is advisable to go off and to return after a sufficient interval to make sure along which road the enemy is marching. It is not a good plan to circle round or hover over the head of a column, as a small body of the enemy

may in this case deliberately take a wrong road for a mile or so in order to deceive the observer.

Transport will often give a clue as to the direction in which to search for the hostile troops.

Snow may make it difficult for an observer to identify localities. On the other hand, roads and railways in constant use and horse exercising tracks show up clearly in the snow, and tracks leading up to trenches and gun emplacements are clearly seen, and give some indication as to whether they are occupied or not.

The snow in front of occupied trenches and gun pits is discolored by fire.

7. For distant or strategical reconnaissance the observer will usually be given a definite course to follow, points over which he is to pass being indicated on the map.

For close or local reconnaissance the observer may be given definite questions to answer, or required to search an area indicated by four or more points on the map. In the latter case the area must be crossed and re-crossed until all the information of importance about the enemy in this area has been obtained.

DETAILS TO BE NOTED.

8. The following are the most important points to note:

Columns of Troops and Transport.

(1) Road along which troops are moving and direction of their march.

(2) Composition.

(3) Point reached by head and tail of main body and time when observed.

(4) Length and composition of advance and rear guard and the intervals between them and the main body.

(5) If the column is well closed up or straggling.

(6) If halted, the side of the road on which observed.

(7) In the case of transport, whether horse or mechanical; whether the vehicles are open or closed, and if the latter, what color; and whether apparently ammunition wagons or supply vehicles.

Ammunition wagons can generally be distinguished on the move by the number of horses to a vehicle; limbers may be seen, and the vehicles are usually alike.

Railways and Stations.

(1) Direction in which trains are moving or facing.

(2) Composition of trains.

(3) Rolling stock and number of locomotives at stations.

(4) Number and movements of transport vehicles about station yards.

To avoid mistakes, rolling stock in stations and yards will always be estimated, and reported as rolling stock for so many trains. For such estimation 30 coaches or trucks will be considered as equal to one train.

The word train, used by itself, will always be taken to mean a train of any number of coaches or trucks actually made up, with engine complete, and such train may be either on the move or stationary.

Ammunition and Transport Parks.

(1) Number and type of vehicles, whether motor or horse.

(2) Color of top of vehicles as this information often gives a clue as to its use.

Motor transport and the wagons of ammunition column are usually parked in some regular formation, but the vehicles of other horse transport are frequently drawn up irregularly.

Transport is sometimes parked round the edges of woods, and especially on roads running through woods. Such transport may escape notice owing to tops of wagons being covered with branches.

Collections of motor cars as opposed to motor trucks may indicate the presence of staffs.

Billeting Areas.

The presence of troops in billets is generally disclosed by their guns, transports, and horse lines. It is difficult to estimate the strength of the troops, but the arm and the area occupied are usually indicated by the position and number of guns, horse lines, or transport vehicles seen, and details giving this information will be included in the report.

The transport vehicles are usually distributed in small groups of twos or threes, and are difficult to distinguish from country wagons.

Where horse lines are extensive and are occupied by night only, the number of vehicles in the line by day affords some indication of the strength of the force. When the lines are occupied the observer should note whether cavalry or artillery. Exercising tracks in the grounds of a country house may indicate the presence of a staff.

Bivouacs.

It is difficult to ascertain the strength of a force in bivouac. Troops are generally distributed round the edges of fields or in woods, and considerable cover from view from the air is obtained. Smoke from bivouac fire will sometimes give an indication of the presence of troops.

The strength of a force can be estimated by the area covered, or the transport or guns found, and detail giving this information will be included in the report.

Aerodromes and Landing Grounds.

The location of hostile aircraft landing grounds is comparatively easy, and may be an indication of the position of his troops. The number of tents, and aircraft seen will be noted.

Troops.

(1) The position of the enemy's reserves and their strength.

Formed bodies of troops are usually easily located unless the country is well wooded and means of concealment from aircraft is available.

(2) The position of headquarters of formations.

These are often indicated by motor cars or the coming or going of messengers. The location of headquarters is important as giving an indication of the disposition of troops.

(3) The position of batteries.

Guns of armies in movement are usually easy to find, as little opportunity for concealing them exists when brought into action suddenly. Where guns are difficult to find the teams near at hand are frequently apparent.

On the other hand the guns of a defensive line are difficult to locate. Emplacements are hidden away under trees, and in orchards and gardens. The teams are hidden well in rear. A small wood is frequently planted to conceal guns; consequently the appearance of a new wood is worth investigation.

Alternative emplacements are almost invariably arranged, and it is necessary to fly directly above them to tell whether they are occupied or not. Batteries seldom show signs of life when an airplane is overhead except during a battle. Overhead cover can generally be noted by the observer, if he knows the position of the battery beforehand. In this case, however, the only way he can tell if the emplacements are occupied is by seeing the guns actually firing, or men going in or out. An emplacement in the open is conspicuous, and is, therefore, unlikely to be much used in the future.

It is sometimes obvious that gun emplacements are occupied, but, generally speaking, it is difficult to determine whether this is so or not.

Flashes are a valuable guide, but care must be taken to distinguish between real and dummy flashes.

Field guns have a yellowish white flash, which gives a decided kick forward.

Small howitzers have rather a larger and yellower flash than the field guns, followed by a little puff of smoke.

Large howitzers have a much larger and redder flash than the smaller ones, and there is quite a big puff of yellow smoke succeeding the flash, which appears some two feet above it.

German batteries sometimes use a flash reducer. The effect on the flash is as follows: The flash is red and appears a bit in front of the muzzle of the gun, followed by a thin puff of smoke. This is very apt to be taken for a dummy flame.

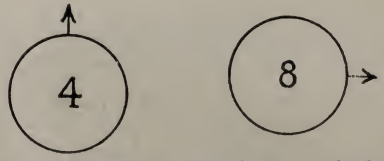
Dummy flashes look about the same in color as gun flashes, but do not have the kick forward which distinguishes the latter. They are very difficult to distinguish from gun flashes, and it is necessary to observe if shell falling in our lines coincide with the flashes seen.

When guns are seen in the open the observer will note whether there are any limbers or signs of personnel in the vicinity, otherwise they may be dummies.

Observers will study the map carefully for woods, behind which howitzers are likely to be placed, before making a gun reconnaissance of an unfamiliar area.

Artillery Staffs can generally indicate the locality of hostile batteries. The observer must search these areas carefully, and also watch for flashes from behind our own line. The latter method is often successful when the former fails. Wheel tracks show up well on stubble, plough and snow, but do not show up well in wet weather. Tracks of men going to and from batteries show up well on snow, and are a good indication.

Gun pits will be marked on a special squared Artillery map by a circle showing the number of pits in it, giving the direction in which they face, thus:—



A note will be made whenever possible as to whether gun pits previously reported are occupied or not. Unless an observer is quite sure that gun pits are occupied he will report them as "apparently occupied."

Sham gun pits are often made behind the guns, all hedges in front of such pits should be searched. Particular attention will be paid to orchards close to roads. It is a good plan to turn suddenly after passing a suspected area, as guns often cease firing when an airplane approaches. Shelling by either side will be noted and its locality and intensity accurately reported.

Entrenchments.

Trenches are easy to locate, but as a rule it is difficult for an observer to report whether they are occupied or not, as the bottoms of trenches are almost invariably in shadow. Debris behind the trenches is not a reliable indication.

There are usually communication trenches leading from the main line to roads or tracks in rear. These exits will be looked for as they are likely to be collecting places for reliefs.

The position of trenches will be noted; a good method is to fill in the exact position and shape on a large scale map or previously prepared enlargement.

Photography is the best method of recording observation of trenches. When a network of trenches exists, it is difficult to draw them in correctly, and considerable time is required to do so.

If information is required as to whether a strong point in the trenches has been destroyed, the point will be examined carefully with glasses or telescope to see where the shell holes have been made. Reports will state whether shells have fallen in the point to be destroyed, but it is impossible to go further than this.

Miscellaneous.

Large store tents, the number of barges on canals, and the amount of transport at docks will be noted. Streets that are empty but littered with straw denote that horse transport or mounted troops have been resting there.

The observer will report whether factories are working or not, and be on the lookout for new entrenchments, working parties, and general signs of activity anywhere.

To see properly into towns and villages, it is necessary to get right over them; looking down at them from an angle is useless.

It is hard to tell from the air where an observation balloon is anchored. When information on this point is required the following details will be obtained from Kite Balloon Sections:

(*a*) The probable horizontal distance.

(*b*) The direction of the winch from a point vertically beneath the balloon.

These details should give an observer a clue to the exact position of the winch.

General Instructions as to Reporting.

9. Facts only are to be reported; it is the duty of the staff to make the deductions.

An observer will always report if he is in any doubt regarding the reliability of his observations.

If only a number of small details are seen it is advisable to add the general impression formed by the observer, but it must be made quite clear that this is merely an opinion and not necessarily a fact.

A short positive or a completely negative report, if accurate and reliable, is always of great value. A profuse report, if uncertain, may be misleading and dangerous. The time at which each place was visited must be recorded, and whether A. M. or P. M. It will be stated wherever observation was difficult or easy.

The presence and, if possible, the extent of any fogs will be reported.

Reports will be written out fully in the recognized manner, headings being as far as possible filled in before leaving the ground. It must be remembered that the omission of any of the usual headings will reduce the value of a report or may even render it useless.

A rough diagram will often be of great value in elucidating the meaning of a written message. When using the regular report form, a hard pencil must be used and pressed firmly down on the paper.

Records of flights in the air will be reported separately. The position of all gun flashes seen, whether they have been signalled down or not, will be reported at once after landing to the Artillery Commander concerned.

A greater value can frequently be derived from a reconnaissance if the observer attends with his written reports at a report center. He can then explain any point which he may not have made quite clear, and he is often able to supply further information when questioned. When the landing ground is close to the report center, information of an urgent nature may be given verbally in the first instance, but a written report will also be made out on the first opportunity.

Reports must reach their destination as soon as possible. Much of the value of aerial reconnaissance will be lost if the information so quickly gained is delayed in transmission. The number of the reconnaissance must be inserted in the proper place on the report, and the distribution of copies must be stated.

10. The following means of reporting observation are available: (*a*) Personally to headquarters of a formation; (*b*) by a message dropped at a report center; (*c*) by a signal (lamp or wireless) from the airplane direct to a ground station.

The observer must be informed which method he is to employ, but in every case a written report will in addition be rendered as soon after landing as possible.

Reporting observations by signal, except for ranging Artillery, will only be used in special cases. For reporting most forms of reconnaissance it is better to land, but signalling may be used with advantage—

(1) To communicate the dispositions or movements of an enemy during an action, when they are sufficiently close to influence the immediate action of troops engaged.

(2) To keep Commanders informed of the progress of their leading Infantry so as to facilitate the close support of the Artillery.

(3) To give important information quickly to advanced troops or covering detachments.

Wireless or electric signalling lamps will usually be employed. The ground station, which should be situated in close proximity to the advanced report center of the formation (Corps or Division), must be clearly defined so that the observer may know where to direct his light and where to look for answer signals.

The message should be as short as possible.

On landing the observer is responsible for seeing that his written report is transmitted by the most expeditious means, the report will be made out on a special form as shown here:

Observer's Report Form.

Date.	Airplane.		Pilot.	Observer.	Ref. map.	Hour at which reconnaissance commenced.	Hour at which reconnaissance concluded.
	No.	Type.					

Time.	Place.	Observation.	Page No.

Signed.....*Observer.*

These forms are prepared with carbon paper so as to make three copies simultaneously and are issued to observers.

Messages may be dropped at pre-arranged places when it is desirable to save time in communicating important information, or when no landing ground near a report center is available. Information for advanced troops or covering detachments may be communicated in this way. Message dropping stations must be arranged beforehand so that the observer may know where to look for them.

Before a message is dropped from an airplane the pilot will make a complete circle above the place where it is to fall. The responsibility

for picking up messages dropped at report centers rests with headquarters of the formation.

Ground observers must have good glasses and endeavor to follow the message bag as soon as it leaves the airplane, marking down the point where it reaches the ground with reference to some well-defined object.

EXAMPLE.

PRE-ARRANGED SHOOT ON HOSTILE BATTERY FOR DESTRUCTION.

Squadron call, L. Observer's call, 1. Battery call, R (9.5 inch Howitzers). Target call, R1.

Time in minutes.	Squadron. Observers and battery call.	Signal.	Remarks.
0	L1 R	B	Repeated until K put out.
1	L1 R	T	Acknowledge K.
...	L1 R	A R1	Stand by for pre-arranged target, *i.e.*, hostile battery.
2	L1 R	T	L acknowledged.
4	L1 R	G	Battery fires No. 1 gun. Target No. 2 emplacement.
5	L R	B9	
	L R	G	No. 2 gun fires.
6	L R	A2	
	L R	G	No. 3 miss-fires.
7	L R	W	
	L R	G	No. 4 fires.
8	L R	Z8	
	L R	G	No. 1 fires.
9	L R	Y2	
	L R	G	No. 2 fires.
10	L R	Z6	O. K. No. 3. Observation sent with reference to No. 2 emplacement.
	L R	G	No. 3 fires.
11	L R	OK	This of course refers to No. 2 emplacement.
	L R	G	No. 4 fires.
12	L R	Y3	

and so on, until Battery Commander is satisfied that each gun is ranged. He then puts out V and fires for effect with all four guns at No. 2 hostile emplacement. The observer does not see the V, but on sending the next G sees four rounds bursting near the target in rapid succession. He realizes that the battery is firing for effect and send mostly corrections. When the observer is satisfied that sufficient effect has been obtained on No. 2 hostile emplacement he switches onto No. 3 emplacement, using the signal SW and the clock code. Fire for effect is opened forthwith on No. 3 emplacement, then on No. 4, and finally on No. 1.

SPECIMEN FORM FOR PILOT'S AND OBSERVER'S REPORT.

No.....Squadron, U. S. A. S. Date.....

Type and Number.	Pilot and observer.	Duty.	Hour of		Remarks.
			Start.	Return.	

Report on Flashes Seen or Reconnaissance of a Hostile Battery Position.

1. Flashes seen at.....	
2. No. of flashes seen.....	
3. Time seen.....	
4. Accuracy.....	
5. Area shelled or direction of flashes.....	
6. Action taken by observer and results observed....	

General Description of Position.

7. (*a*) Co-ordinates of anks	
(*b*) Nature of tracks, dug-outs, camouflage, signs of occupation, etc.....	
8. Registered No. in A. H. B. list.....	(To be filled in by Recording Officer.)
9. Photo Nos.....	
10. Previous reports.....	

Report on Artillery Observation.

	1.	2.
1. Battery ranged with.....		
2. Nature of target.....		
3. Co-ordinates of target.....		
4. No. of single rounds observed..		
5. Results of single rounds observed.		
6. Whether battery fired for effect..		
7. Approximate No. of rounds fired.		
8. Results of fire for effect.....		
9. Shoots observed by pilot or observer.....		

Signature.....

Date.....

Specimen of Daily Report.

No. 1 Squadron, U. S. Flying Air Service

Time seen.	Co-ordinates of Position.	Call.	Description.	Accuracy.	Type of Gun and Area Shelled.	Engaged by.	Time.	Result and Remarks.
Hostile Battery Positions Engaged or Points Registered.								
		53	.....	.....	.....	24th Siege.	p. m. 1.10	5 rounds Y, shoot stopped owing to clouds.
		36	.....	.....	.....	21st Heavies.	3.00	1 O. K. Several Y's. Big explosion behind northern pit.
			3 trench points.	.....	.....	115th Bat. F. A.	3.15	Registration successful.
Active Hostile Batteries.								
a. m. 11.30	A 12 b 42	24	2 hows. in pits behind houses.	A	Hows. shelling K 15 d.	33d Siege.	a. m. 11.50	2 O. K.'s on pit at A 12 b 42. 4 Y's on A 12 b 53.
p. m. 2.30	B 19 d 38	55	4 guns.....	C	Apparently firing from houses.	.....		
3.10	S 30 b 30 to S 30 B 33	44	4 guns along hedge.	B	Probably 77-mm. guns.	23d Heavies.	p. m. 3.30	Several Z's, battery stopped firing. Shoot interfered with by H. A.
Hostile Battery Positions Reconnoitered.								

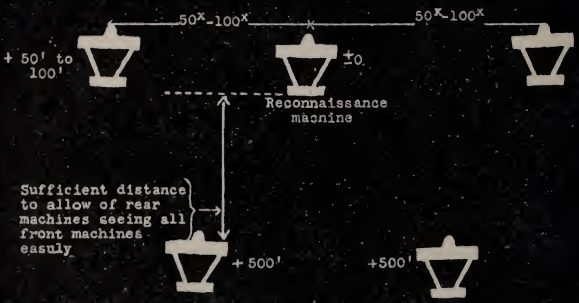
Signature.....

Date.....

FORMATIONS ADOPTED.

(a) Reconnaissance of 6 F.E.'s

(b) Reconnaissance of 5F.E.'s

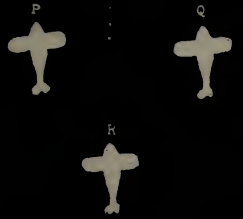


Observers of all machines except reconnaissance machines facing the rear.

J.B.

(c) De Havilland Escort. 3 Machines

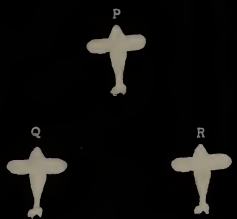
(i)



P and Q Same height about 1,000' above machine being escorted.

R Slightly lower

(ii)



P About 1,000' above the machines being escorted

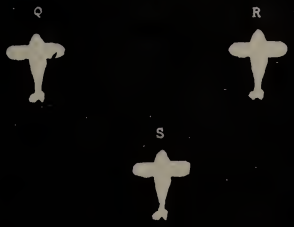
Q and R Slightly lower.

(d) De Havilland Escort.

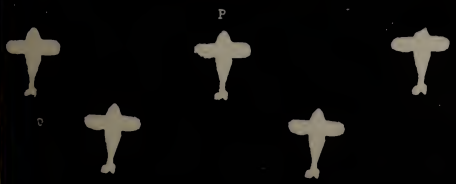
4 Machines.

Q, R, S. Same height.

P Slightly higher and about 1,000 above machines being escorted



(e) De Havilland Escort. 5 Machines.



P (group leader) slightly higher than remainder

(f) De Havilland Escort. 6 Machines.

Usually fly in two groups formed as in (c) above.

(g) Combined formation of 4 F.E.'s and 2 Scouts.

P is reconnaissance machine

Q watches the formation

R and S watch front and flanks

Scouts watch rear and fly above the F.E.

(h) Combined formation of 6 F.E.'s and 3 Scouts.

P and Q are reconnaissance machines

R or S watches the formation.

Remaining 3 F.E.'s watch front and flank.

Scouts watch rear and fly above F.E.

J.B.

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